THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single copies..... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, OCTOBER, 1892.

THE publication of the second paper in the series on testing material by Drs. Dudley and Pease has been postponed for a short time, to await the completion of some important investigations. The authors wish to make these papers as complete as possible, and a short delay is preferable to a too hasty publication.

THE Union for the Improvement of the Canals of the State of New York has called a convention to meet in Buffalo, October 19, to which boards of trade of the cities of the State and other similar associations are invited to send delegates. The object is to give expression to popular opinion in favor of maintaining and improving the canals, to organize a strong permanent association, and to favor the formation of local organizations for the same purpose.

WE are requested to state that the reference made by Mr. D. E. Hughes, in his paper on Transition Curves, in the July number of the JOURNAL, was to a paper read by him before the Technical Society of the Pacific Coast in April last, and not to a paper published some years ago, as assumed by Mr. Ward in his answer made in the August number. Those who have followed the discussion will recognize a material difference.

THE American locomotive has again shown that its characteristic qualities are unaffected by climate. The elaborate blue book giving an account of the investigation into the Baldwin engines, ordered by the New South Wales Railway authorities, shows that the whole body of railroad men there, though trained in the English school and accustomed to English engines, greatly preferred the American engines for their great hauling power, easy riding on the road, and flexibility in taking curves. Even the attack on the engines appears to have been mainly actuated by political motives, and did not allege that the engines were inferior to English engines, but to certain "Scotch Yankees," which are passenger Mogul engines built after American drawings by the Dubs Works in Scotland. A large number of tables are given in the blue book showing the cost of repairs, etc., but it is amusing to find that the greater part of the cost was due to collisions and derailments caused by misplaced switches, etc. Diagrams and particulars are given of the performance of a 10-wheel passenger engine, which for several miles exerted a tractive force of over 19,300 lbs., a performance which we recommend to the notice of our cotemporary, the London *Engineer*, as it goes far to explain why the British colonies select American engines when there is work to be done. A note to a trial of a consolidation freight engine on a grade of 2½ per cent. with 9-degree curves states that it hauled a greater load than is usual in good practice in Great Britain on a 1 per cent. grade with far easier curvature.

THE torpedo-boat *Cushing* has had her first trials with torpedoes; they took place in Peconic Bay, at the eastern end of Long Island, and were very successful. The *Cushing* has been in commission for some time, but has had no opportunity for practice, because the torpedoes were not available. A supply of the Whitehead pattern, however, has at last been procured and can be used.

THE International Railroad Congress met in St. Petersburg, August 22, about 300 delegates being present. A number of interesting reports were ready for the Congress, to some of which reference has already been made in our columns. The meeting is referred to on another page.

THE Russian Trans-Caucasian Railroad is proving successful as a commercial as well as a military line. The receipts from general traffic last year were over 16,000,000 roubles, largely exceeding the estimates made when the road was built. The railroad is doing much to make Russian influence the ruling power in Central Asia in a commercial as well as in a political way—and in the present age the two have a very close connection.

REGULAR work has been begun on the Western Siberian Railroad. Resident engineers have been appointed for several sections, and a considerable force is at work on the grading. There is no doubt of the intention to push the work, and full preparations are being made for a supply of material as it is needed.

UP to the present time there have been very few locomotives in this country with driving-wheels over 6 ft. in diameter, and indeed 6 ft. has been an exceptional size. The largest drivers we can now recall were 7 ft. 6 in. in diameter, and were used for a time many years ago on the Camden & Amboy Railroad. Now that there is a demand for fast time, however, the large driver is to be tried in service. The New York Central & Hudson River Company has just turned out an engine with 7 ft. drivers from its West Albany shops; and the new compound engine which is under construction in the Pennsylvania shops at Altoona is also to have 7-ft. driving-wheels.

SO many towns and cities are now using electric motors on their street cars that it will seem a little strange to note that New York has just begun to operate its first electric railroad. A few cars with storage batteries were run on

the Fourth Avenue line some time ago, but the experiment was soon discontinued. The road now worked by electricity is that of the Union Company, which owns several lines of large traffic, all in the annexed district north of the Harlem River. These lines are not new, but have hitherto been worked by horse power. Overhead wires are used, the current being taken from a single power station placed in a convenient situation.

THE eastern section of the Merwede Canal, which is to give the port of Amsterdam in Holland a new outlet, was recently opened. This section is 28 miles long, and extends from Amsterdam across the Leyden Branch of the Rhine and past Utrecht to the Leck near Vreeswyck. It has a minimum depth of 10½ ft. and a breadth of 100 ft. The second section is now under construction; it will be 15½ miles long, from the Leck to the Merwede near Gorinchem. The first section has been under construction for several years, and is an important work.

AT the Iowa State Road Convention, held recently in Des Moines, some good papers on road construction and maintenance were read. A permanent organization was formed to agitate the question of road improvement, and arrangements made to bring the matter before the Legislature, with a view of securing improvements in the road law.

It is to be noted that all the speakers condemned the old system of working out road taxes; and also that many of them advocated the use of wider tires on wagon wheels.

IN Missouri also a road convention was recently held, at Chillicothe, which was largely attended. This convention adopted resolutions in favor of large road districts, with proper supervision, and the classification of roads into three divisions, according to their character and importance. State aid to the districts for macadamizing the more important roads was advocated. Here also the working out system for road taxes found no friends, and the broad tire had many advocates. In connection with the meeting there was quite a large exhibit of road-working machinery.

THE survey made by the steamers *Thetis* and *Albatross*, to determine the practicability of laying a telegraph cable between California and the Hawaiian Islands, has resulted in the discovery of a lane along the bottom of the Pacific Ocean with an average breadth of 300 miles and a length of about 2,100 miles. The crust of the earth along the belt was found to have a gently undulating surface, with here and there a sharp peak rising abruptly toward the surface of the ocean. Three lines of deep-sea soundings were run between October, 1891, and May, 1892. Two were along great circles of the earth between Monterey Bay and Honolulu and Point Concepcion and Hilo Bay, respectively, and the third was on a rhumb line between Monterey Bay and Honolulu.

The route considered as the most practicable one for the cable lies at an average depth of 2½ nautical miles along a mercator line between Monterey Bay and Honolulu—that is, nearly straight on the charts in ordinary use by navigators. This route is found to require a minimum length of cable in passing over an even bottom consisting of soil which is favorable for its protection and preservation, avoiding submarine mountains and volcanic regions where substances exercising injurious chemical action on the covering of the cable are likely to exist and where future convulsions may cause its destruction.

THE loss of the steamer *Western Reserve* has attracted much attention among shipbuilders, from the fact that it is the first serious casualty to any of the large steel steamers which are becoming so numerous on the lakes. The only survivor states positively that the ship broke in two in a sea which was not by any means as high as some that are met with, and it seems to be a grave question as to whether there was not some structural weakness. Her builders have always borne a high reputation, and they claim that in every respect she was fully equal to other boats of her class. They have given information freely as to the design of the boat and the material used in her construction.

There seems to be, in fact, no doubt that the *Western Reserve* was well and honestly built. The question raised by her loss is really as to the designs in use, and it may well be asked whether the tendency has not been to secure light draft and great carrying capacity at the expense of complete safety; and whether the shocks and strains, to which vessels of great size are subjected, have not been underestimated. These are matters which need careful and serious consideration.

THE INTERNATIONAL RAILROAD CONGRESS.

THE International Railroad Congress, the most important body of the kind in Europe, this year held its meeting in St. Petersburg, the session lasting from August 20 to the end of the month. We have before referred to the organization of this Congress, which is composed of delegates from railroad companies and from the ministries of railroads and public works of the different European countries. As with most of our own associations its powers are limited to advice and recommendations for the most part, and its decisions are not binding on members; but it has authority to settle certain questions relating to exchange of traffic and international connections.

In the intervals between the meetings of the Congress a permanent commission is in session, which has charge of the preparation of reports and other business to be submitted. This year a large number of reports were prepared and printed, some of them of much value—notably those on the wear of steel rails, on compound locomotives, and on the equipment and management of secondary or light railroads—and much business was ready for the meeting.

Full reports of the proceedings have not been received, but those at hand indicate that the discussions were not as full or extended as usual, and that a large part of the time was devoted to entertainments and to visits to and inspections of the Russian railroads. General Petroff was chosen to preside over the Congress, with M. de Laveleye as Chief Secretary, and the proceedings were conducted in the usual form, the members being divided into sections. To each section was assigned a certain class of questions, and its decisions were submitted to and discussed in general session.

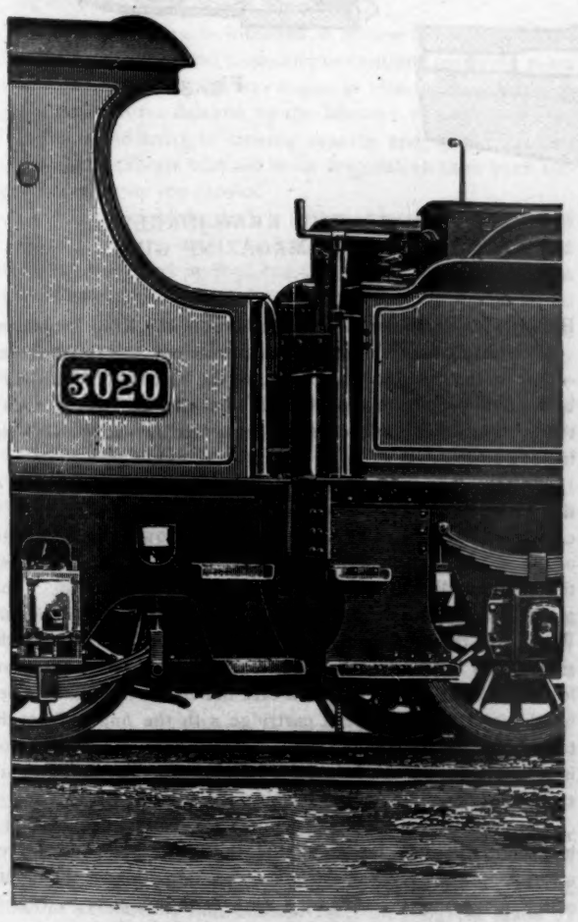
The more technical questions relating to construction of road and equipment seem to have been lightly passed

over. The most extended discussion was on a traffic question—the best methods of promoting passenger business, with especial reference to the "zone tariff" system as adopted by the railroads of Austria-Hungary. The zone tariff system does not seem to have found many strong advocates, and the final decision was that no general rules can be laid down, but the passenger system in each country must be adapted to its special needs and local conditions.

The Congress will hold its next session in London, in 1895. That meeting will be the first to be held in England; France, Italy, and Belgium have been the countries heretofore visited.

ENGLISH ENGINE AND TENDER STEPS.

THE engraving herewith represents the steps on an express passenger engine, which was "converted" from the broad gauge on the Great Western (of England) Railway from the designs of Mr. William Deane, Locomotive Superintendent of that line. The readers of this JOURNAL know some of our opinions of English locomotives, or



ENGLISH LOCOMOTIVE STEPS.

rather of their performance. There are, however, some features in them which might be imitated by us here to advantage. Among these are the steps which are illustrated herewith. They are long, broad and low and easy of access. Most of the steps on American locomotives and tenders are short or narrow and high and very difficult to reach, especially when the engine is on a bank. The niggardliness of human nature sometimes manifests itself in very curious ways. It has been remarked before that a mechanic in his natural state abhors ample bearing surface. Those of us on the shady side of life can all remember when bearing surfaces of shafts were almost universally made too small, and were incessantly giving trouble on that account. One of the early locomotive builders in this country never could be induced to give sufficient margin of strength in the spring hangers of his locomotives, and consequently they were incessantly breaking. A few cents would have paid the cost of making them adequately strong, but he always resisted any proposal to increase their dimensions. Until within a few years locomotive boilers were nearly always too small, when they could have been made larger. This trait of mechanical meanness led people to make the bearings of shafts and the spring hangers and boilers of locomotives just as small as it was possible to get along with. There was everything to gain by amplitude in these parts, and nothing to lose; nevertheless, these people, who were disposed to be "near," seemed to find it impossible to be liberal even in feet and inches. Old Ross Winans was wont to tell his apprentices, "Boys, if you must make a thing strong, make it d—n strong." Nevertheless, he made his boiler braces so weak that many a poor fellow was sent to that other world, which we all hope will be a better one than this, by the breaking of the braces, which were by no means "d—n strong."

Now, in designing locomotive and tender-steps, many of their builders in this country seem to be animated by this same kind of mechanical parsimony. The steps have been made just as small as it was possible to make them and have them serve the purpose for which they are intended, which occasionally they did not do, and the lives or limbs of those who are compelled to use them were sacrificed uselessly. Mr. Deane's steps would, it is thought, be improved if the lower step on the engine and the upper one on the tender were made longer. There is everything in the way of safety to be gained by making them of ample size, and nothing to lose. We may suggest that English practice in this respect might be copied to advantage, and may paraphrase old man Winans's advice by recommending profane amplitude for not only those engine and tender steps, which are in the position shown in our engraving, but also those on the cowcatcher and other localities.

THE KRAG-JORGENSEN REPEATING RIFLE.

THE announcement that the Small-Arms Board had at last found a repeating rifle worthy to be recommended for adoption in the military service of the United States has been received with satisfaction by all who desire that this country shall keep abreast, at least in the matter of military material, with the other great powers. This satisfaction is the greater as it has been feared, from the time taken to reach a decision, that either a suitable arm could not be found, or that other influences would operate against a favorable recommendation.

Even now it is by no means certain that the end has been reached, as the recommendation of the Board has yet to be formally approved by the War Department before any steps can be taken toward the introduction of the new arm.

The generally received impression that the Ordnance Department of the Army was so wedded to the Springfield system of breech-loading small arms that no proposition for a change would secure its approval seems warranted by a perusal of the

annual reports of the Chief of that bureau during the past six or eight years. That the Springfield system of breech-loading small arms is the best, or anywhere near the best, of the many military arms in use will not be admitted by many American experts whose opinion is worth the having.

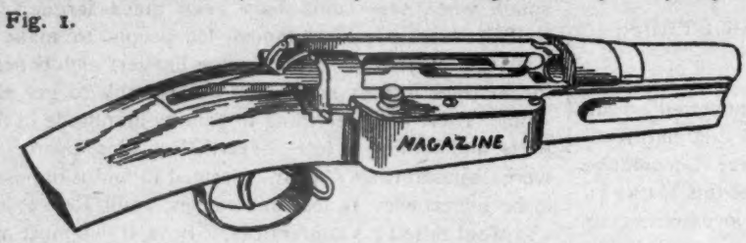
The Springfield system of breech-loaders had its birth soon after the close of the Civil War. The existing arm—the Springfield muzzle-loader—of that war was, in the first instance, converted into a breech-loader. In the conversion the barrel was shortened and the caliber reduced from .57 to .50. In the model of 1873 the caliber was further reduced to .45; and this arm, with some unimportant modifications, is the one now in use in our military service.

If we have been standing still during these twenty years, such has not been the case abroad; and it may be interesting to recall some of the changes which have taken place in the weapons of European armies in the mean time.

Following the Franco-Prussian War, wherein the value of the breech-loader was so signally established, there was a general re-armament, the Chassepot and the needle-gun were discarded, and a single-loader rifle with a caliber of about .43 was adopted by all the great military powers. The Germans had the Mauser; Austria the Mannlicher; Italy the Vetterli; Russia the Berdan, and England, discarding the Snyder, took up the Martini-Henry. It was not long, however, before the question of a repeating arm began to be agitated, and some six years ago the work of effecting this change was entered upon by all the larger European powers except Russia. Generally speaking, the existing arm was retained, or rather modified to meet the new conditions, with practically the same caliber. Before the change from a single-loader to a repeater was wholly completed in Germany, and when it was about being begun in England, the discovery by Professor Hebler that a rifle of small caliber possessed greater range and accuracy and a much flatter trajectory than the existing caliber, at once caused a halt in the work of re-armament. The advantages claimed for the small-bore arm were so great, and shown by careful experiment to be so well established, that notwithstanding the enormous sums already spent in introducing the large-calibered repeater, Germany at once set about again changing her armament, and at the present time all the German troops—of the first line at least—are supplied with the new arm. The other powers have followed her lead, or rather, perhaps, that of France, which was the first great power to adopt the small-bore repeating rifle, in the well-known Lebel. This gun is really a Kropatchek repeater, and has the modified Chassepot or Gras bolt and the spoon elevator. The German arm is the Mannlicher, with a fixed magazine holding five cartridges; the English, the Lee-Melfort, which has a detachable magazine for eight cartridges. The Lebel, it should be said, has a tubular magazine under the barrel, and contains eight cartridges. The small-calibered arm recently adopted by the Russian Government is said to be a modified pattern of the Lebel.

About the time the magazine rifle was being introduced into European armies there were issued to sixty-odd companies of our own army three different patterns of repeating arms for a sort of popular trial. Among these were the Lee and the Hotchkiss. Want of unanimity of opinion among the officers having them in charge, added to a decided preference on the part of the officials of the Ordnance Bureau for the retention of the Springfield, led to the prompt rejection of them all. The Lee, afterward adopted by Great Britain in a modified form, was believed by many experts to be the most promising arm before the Board, whose final decision was in favor of the Krag-Jorgensen.

Fig. 1.



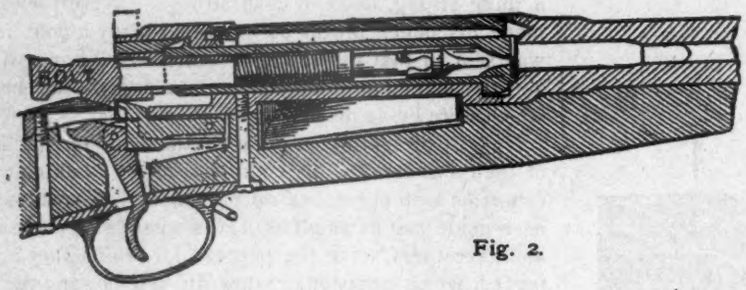


Fig. 2.

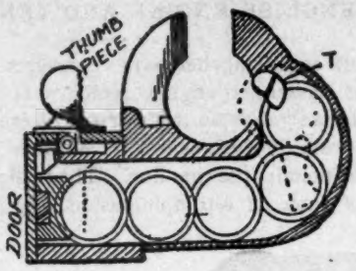


Fig. 3.

THE KRAG-JORGENSEN MAGAZINE GUN.

Like nearly every military arm now in use, this is a bolt gun—that is, the opening and closing of the breech is effected by a bolt moving in a direct horizontal line with the bore, carrying the firing-pin and the necessary spring mechanism for discharging the piece.

The accompanying cuts will show the principal features of the gun. In fig. 1 the breech-block is open; in fig. 2 it is closed and ready for firing, while fig. 3 shows a cross-section of the magazine, which holds five cartridges. To load the piece the bolt handle is thrown up to the vertical position. This movement starts the empty cartridge-case and unlocks the bolt. By pulling the bolt to the rear the empty shell is thrown to the right and a fresh cartridge is admitted from the magazine, unless the cut-off is on, in which case the chamber remains open for the insertion of a fresh cartridge with the fingers from the top. This last movement sets the firing-pin spring. The bolt is then returned to its original position, shoving the new cartridge into the chamber and cocking the piece.

The magazine is a fixed horizontal box, and is filled through a horizontal door on the right side, the cartridges being forced up by a spring. To use the piece as a single-loader the mouth of the magazine is closed by a gate or thumb-piece, *T*, fig. 3, after which it is manipulated like any single-loading arm.

The adoption of the new arm will place the American soldier upon an equal footing, not only with the soldiers of the great European powers, but also with those of many inferior ones already armed with repeating rifles. The particular merits claimed for the arm under consideration are simplicity of mechanism, ease of manipulation, the rapidity with which it can be changed from a single-loader to a repeater, or the reverse, and its ability to withstand the trying conditions of actual service, especially the presence of rust and dirt.

The Krag-Jorgensen under trial was made especially for trial by the American Board, and is said to be an improvement upon the weapon now in use in Denmark and Norway. The original arm has a calibre of .315, and with smokeless powder has given an initial velocity of over 2.000 ft. per second. The gun under trial had a caliber of .30, and with Wetterin powder gave velocities of something over 1,800 ft. Whether the caliber will remain that of the original arm or be made something less remains to be decided when the question of its adoption is finally settled. Its weight is 9.4 lbs., and it carries a 238-grain bullet. Its inventors are the Superintendent of the royal manufactory of arms at Kongsberg, Norway, and a battalion armorer.

It may be added that this action of the Board has still to secure the approval of the Ordnance Bureau, and that it will meet active opposition from a number of American inventors. The Krag-Jorgensen gun was patented in this country over two years ago.

NEW PUBLICATIONS.

MINERAL RESOURCES OF THE UNITED STATES: CALENDAR YEARS 1889 AND 1890. By David T. Day, Chief of Division of Statistics, United States Geological Survey. Washington; Government Printing Office.

The present volume is intended to review the mining statistics of the years 1889 and 1890, and to continue for those years the series of reports which was begun in 1886. Its appearance has been somewhat delayed by the lateness of some branches of the mining industry in making reports, and by the fact that several of the experts who aid in its preparation have been employed in work on the census.

The importance of the work is indicated by the statement that in 1890 the total value of the mineral products of the United States was estimated at $656,604,700; nearly half of this great sum—$307,334,200—being the value of metallic products, and the rest of non-metallic products, such as coal, lime, building stone, petroleum, etc. This is a greater amount than in any previous year.

Experience has enabled Professor Day to improve the arrangement of his figures and to present results in his tables in a much more satisfactory way than is done in many statistical volumes. The grouping and presentation of figures is an art not quickly learned, and which some men never do learn; but in this respect there is very little fault to be found with the present volume.

THE LAW OF INCORPORATED COMPANIES OPERATING UNDER MUNICIPAL FRANCHISES. VOLUME I. By Allen Ripley Foote. Cincinnati; Robert Clarke & Company. (Advance Sheets.)

Mr. Foote has undertaken, in preparing this book, a work of no small magnitude. His object is to give a digest of the laws of the different States governing companies holding municipal franchises, such as those for operating street railroads, telegraph and telephone lines, furnishing water, gas, and electric light, and the like. He has, as he says in his preface, "sought to elucidate principles and clearly to define strategic points in order to measure by fundamental rules the progress made by the several States in aligning legislation with the requirements of such rules." His purpose is also to bring out discussion of the principles on which legislation of this kind should be based. In other words, his object is to present a study in economic legislation, and not a mere digest of existing laws.

The first volume, which is now before us in the advance sheets, is devoted to the discussion of the law and the legal principles involved; the digests of the State laws will follow in a later volume. In preparing the latter, Mr. Foote has called in the aid of a lawyer in each State, and of Mr. Charles E. Everett as Legal Editor, and purposes making each chapter as complete as possible. The plan of this part is excellent, and the amount of labor required to carry it out may be estimated by those who have had occasion to deal with or consult the laws of one or more States. If the second volume is worked out according to promise, the book cannot fail to be of much value to a large class of people.

In his discussion of principles Mr. Foote holds to the policy of granting municipal franchises of the classes indicated to private corporations, the public authorities retaining the right of regulation, both as to the service rendered, whatever it may be, and the rates to be charged for it, the latter to be so restricted as to give no opportunity for excessive profits. To secure the best service, it is necessary that these franchises must be to a great extent monopolies; and Mr. Foote believes that in almost all cases the public will receive more from an industrial monopoly than from a political monopoly, or to put it in another way, that better service can be secured by the hope of profit than by reliance on public spirit. There are many persons who may feel disposed to differ from his views; but his conclusions are in general of a practical character and well worked out. The great difficulty in practice has been and will continue to be with the regulating power in this system.

The discussion includes, besides the statement of principles, some historical chapters showing the general course and tendency of legislation in the past, and it is very interesting reading to those who have at all studied or wish to study the subject.

SOME NOTES ON THE HOLLAND DIKES. By William Starling. *With Discussion.* Printed for the Author.

This is a reprint of a very full and careful paper read before the American Society of Civil Engineers by Mr. Starling, who has evidently studied the methods pursued in that country, in connection with his own work on the Mississippi levees. It is accompanied by maps and a number of drawings and diagrams, and gives a condensed but well-connected view of the subject. The reprint also includes the discussion of the paper, in which a number of members of the Society took part.

DUTY AND CAPACITY TESTS OF WORTHINGTON HIGH DUTY PUMPING ENGINES ON WATER WORKS AND PIPE LINE SERVICE. New York (86 Liberty Street); Henry R. Worthington.

This is a volume of 200 pages, with many illustrations, containing reports of tests of pumping engines of the class indicated by the title. Some of them have appeared before in technical journals or in the transactions of technical societies, but they are now presented for the first time in collected form. They include reports of tests made in connection with waterworks in Brooklyn, Chicago, Minneapolis, Lowell, Montreal, London (England), and other cities, and with several pipe lines, sixteen tests in all being reported by different engineers. While devoted to the tests of one type of engine, the book incidentally gives a good deal of information about pumping machinery and the different conditions under which it is called upon to work.

REPORT OF THE PROCEEDINGS OF THE TWENTY-FIFTH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION, HELD AT SARATOGA, N. Y., JUNE 20, 21 and 22, 1892. Edited by Angus Sinclair, Secretary. New York; published by the Association.

Secretary Sinclair has brought out the volume containing this year's proceedings of the Master Mechanics' Association with his usual promptness, notwithstanding the fact that it contains an unusual amount of matter, and is, we believe, the bulkiest report ever issued by the Association. This is due chiefly to the unusual length of some of the committee reports and the number of tables and illustrations accompanying them. The

most notable of these is the report on Compound Locomotives, on account both of the interest attaching to the subject and also of the amount of information given in the report itself. There are other reports of interest—those on Locomotive Tests and on Tests of Steel and Iron might be mentioned—and some of the discussions are sharp, pointed, and give considerable information. The Master Mechanics' Association is evidently fully alive and quite ready to keep up with the questions of the day as they arise and call for answers.

THE STATISTICAL YEAR-BOOK OF CANADA: 1891. By Sydney C. D. Roper, Assistant Statistician. Ottawa, Canada; the Department of Agriculture.

This is the seventh yearly volume of a publication which, while necessarily somewhat dry and unattractive to the general reader, contains a great body of information which will be valuable to all who have trade relations with the Dominion, or who are interested in its growth and progress. Like the previous volumes, it shows signs of careful preparation, and has a generally reliable appearance and convenient arrangement which do credit to the compiler.

THE COMPASS: VOLUME I, 1891–92. *A Monthly Journal for Engineers, Surveyors, Architects, Draftsmen and Students.* Edited by William Cox. New York; the Keuffel & Esser Company, No. 127 Fulton Street.

Reference has been made from time to time in our columns to the monthly numbers of the *Compass*. We have here the twelve numbers of the first volume bound in a neat book of 192 pages. Its object has been to give information concerning the making of mathematical and surveying instruments and the best methods of using them; new methods of procedure and other topics of the kind.

The promise of the first number has been well kept, and this volume contains much matter that is valuable and worth preservation. Among the contents which deserve special mention are the papers on Series of Numbers and their Practical Application, written by Mr. Cox, which contain much matter set out in a new light, and some ingenious applications of principles. The Gradienter Tables, on pages 156, 172 and 180, are complete, and will be appreciated by many engineers.

The *Compass* will be found convenient by those who want to be posted on the latest improvements in instruments of precision, and it also contains other matters of interest and value.

REPORT OF THE SEVENTH ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS, HELD IN CHICAGO, JANUARY 27–29, 1892. Springfield, Ill.; published by the Society; S. A. Bullard, Secretary.

This number gives a full report of the meeting of the Illinois Society for the current year; containing several papers of value by members, and reports of some good discussions on topics suggested at the meeting. The Road Question; Brick Pavements; Drainage, and other questions of present interest claimed and received full attention at the meeting, and the results are here given.

PRACTICAL CARRIAGE BUILDING: VOLUME II. Compiled by M. T. Richardson. New York; the M. T. Richardson Company. Price, $1.

This is a collection of articles on the subject which have been published from time to time in the *Blacksmith and Wheelwright*, and contains many practical notes which will be useful to carriage builders. Beginning with information regarding axles, it considers in detail the plumbing of spokes, gather of wheels, making yokes and whiffletrees, laying off a fore carriage, special tools, making ovals, blocking corners, making and laying off of patterns, and drawing of tools. Complete instructions regarding the laying off and framing of carriage bodies, construction of carriage parts and wheels, light and heavy sleighs are given. The book is profusely illustrated, and is uniform in size and style with Volume I, which appeared some time ago.

PROCEEDINGS OF THE FOURTH ANNUAL CONVENTION OF THE IOWA SOCIETY OF ENGINEERS AND SURVEYORS. Glenwood, Ia.; published for the Society, Seth Dean, Secretary.

Besides the reports of the officers and the proceedings of the Society this volume contains a number of papers by members on various topics connected with the profession. It shows that the Iowa Society is not lacking in activity and is, in proportion to its membership, doing fully as much good work as other associations of the kind.

IMPERIAL UNIVERSITY OF JAPAN (TEIKOKU DAIGAKU). THE CALENDAR FOR THE YEAR XXIV–XXV MEIJI (1891–92). Tokyo, Japan; published by the University.

This catalogue, covering the current scholastic year, shows the University of Japan to be in a flourishing condition. It includes six colleges—Law, Medicine, Engineering, Literature, Science and Agriculture—each with its own faculty. The roll shows a large number of professors and instructors of various grades, most of whom are graduates of the University; the students number in all 1,346, of whom 132 are in the College of Engineering. The number of graduates on the rolls is 1 582 now living, besides 91 who have died, making a total of 1,673 who have taken degrees.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. VOLUME XVII, 1891. Published by the Royal Engineers' Institute; Chatham, England.

The present volume is devoted entirely to the subject of Sanitary Engineering, and although written presumably for the benefit of the officers of the Royal Engineers, its scope is not restricted to the question as applied to the sanitation of military barracks, etc., but enters chiefly into that part of the subject pertaining to the disposal of sewage, surface water collection, subsoil drainage, house drains and the use of disinfectants.

The problem of how best to dispose of sewage, garbage and refuse is, with the rapid growth of great cities, becoming every year of increasing importance, and one for which no thoroughly practical and satisfactory solution has as yet been reached. In the book before us the various systems of sewerage, as employed and proposed in Great Britain, are discussed, while the questions of construction and materials, and the special appliances for use in buildings are treated exhaustively, and fully illustrated by numerous cuts and fifty-odd more or less elaborate plates. So complete is this part of the work that it might well serve as a text-book upon this subject for engineering students.

The primitive and often haphazard methods employed for the disposal of garbage and sewage by very many American cities of even considerable size explains the frequent outbreaks of typhoid fever and other zymotic diseases. The great wonder is that the mortality arising from shortcomings in this direction is no greater than it is.

A work so thoroughly practical and dealing with a question of such vital importance ought not to be restricted in its readers to the professional engineer.

JOHNSON'S TABLES: STADIA AND EARTHWORK TABLES. Reprinted from *Theory and Practice of Surveying*. By Professor J. B. Johnson. John Wiley & Sons, New York.

The purpose of this volume is perhaps best explained by quoting the Author's explanatory note, as follows:

The great use made by engineers of three of the following

tables—viz., the Four-place Logarithmic Table, the Stadia Table, and the table giving Prismoidal Volumes, has necessitated the building of these in more convenient form than that in which they first appeared in the *Theory and Practice of Surveying*. Since the cost is not materially increased by additional pages, the remaining tables are also included, as well as the entire chapter on the Measurement of Volumes.

The Stadia Tables were computed by Mr. Arthur Winslow, State Geologist of Missouri, and first published by the Pennsylvania Geological Survey. The four-place logarithm tables were originally taken from Lee's *Tables and Formulæ*, a publication of the United States Engineer Corps. The table giving Volumes by the Prismoidal Formula was computed by the Author. It is the only table, he believes, giving volumes by the prismoidal formula at one operation. It may also be used for Mean End-areas. Tables IV and VIII are also original in their arrangement.

In addition to the tables the book contains a chapter on the Measurement of Volumes and the necessary explanations of the tables. In its present form it will be found a very convenient reference book and assistant by the engineer.

CRUISES OF S. M. SHIPS "NAUTILUS" AND "AURORA" OF THE EAST-ASIATIC SQUADRON, 1884–88. By Captain Jerolim Freiherrn von Benko. Published by Carl Gerold's Sohn, Vienna.

This is one of the volumes which are issued from time to time under the auspices of the Austrian naval authorities. They give accounts of the cruises of ships, and are not simply records of travel, but are intended to convey sailing directions for the various ports visited, accounts of currents, lights and other information useful for mariners, and also such notes on the commerce of the various countries as the officers may be able to collect, and which may be useful to merchants at home.

The present volume describes cruises made by the *Nautilus* and the *Aurora* in Eastern waters, visiting many ports in India, China, Japan, and the islands of the Indian Ocean. It contains much valuable information and also some entertaining notes of travel. The statistical part, of course, will be read only by those directly interested, but there is much in the book that others might read with profit. It is a very creditable specimen of the work done by the Austrian Navy.

The book is illustrated by three large maps showing the cruises of the two ships in detail.

TRADE CATALOGUES.

The Lahman-Kirkwood Patent Fuel-saving, Shaking and Dumping Grate-bar. W. H. Lahman, No. 154 Lake Street, Chicago.

This is an illustrated description of a grate-bar adapted for all kinds of coal, from which, it is claimed, very good results have been obtained in service.

Train Signaling System. The Mason Air Brake & Signal Company, Chicago.

This is an account of the system of train signaling by compressed air which is now being introduced by the Mason Company. It is accompanied by drawings and diagrams showing the general construction and details of the apparatus.

Dixon's Perfected Graphite for Lubricating. The Joseph Dixon Crucible Company, Jersey City, N. J.

This is a pamphlet showing the advantages of graphite as a lubricant and the variety of uses to which it can be put, and it gives some facts which are worth the attention of those who have charge of or own machinery. It shows also the necessity of using pure graphite properly prepared.

Emery and Corundum Wheels, Emery Wheel Machinery, Flint and Sapphire Papers. The Springfield Emery Wheel Company, Bridgeport, Conn.

This catalogue contains lists and illustrated descriptions of a great variety of grinding, polishing, and surfacing machines made by the company mentioned. Its size is in itself a proof of the extent to which emery and similar wheels are now used in machine work, and the importance which their manufacture has attained. The catalogue will furnish some useful hints to manufacturers.

The Universal Cutter and Reamer Grinder as Made by the Brown & Sharpe Manufacturing Company, Providence, R. I. Illustrated.

This pamphlet gives a description of the universal cutter and reamer grinder made by the Brown & Sharpe Company, with a number of the applications of the tool to various purposes. The descriptions are generally clear and are very fully illustrated, and give a complete idea of the uses to which the machine can be put. A careful reading will certainly give the machinist or foreman some information, and possibly some new ideas. The pamphlet will be sent to any applicant by the company named.

Air Compressors: Duplex and Single, Actuated by Steam, Belt, Gearing or Water Power. Catalogue No. 7. The Clayton Air Compressor Works, New York and Brooklyn.

This catalogue contains descriptions and illustrations of a number of air compressors of different patterns made by the Clayton Works and adapted to various pressures and to different kinds of work. The use of air compressors is increasing in many directions, and their manufacture is an interesting branch of mechanics, in which no small degree of skill and experience is required. An inspection of this catalogue is required to show the great variety of uses now found for this class of machinery.

Catalogues and Price-lists of the Brown & Sharpe Manufacturing Company: New Edition, 1892. Providence, R. I.

The extent to which the business of this firm has grown is shown by the size of its catalogue. In 1875 a book of 66 pages was sufficient; in 1879 this had grown to 100; in 1889 to 205; last year it had 228, and the present edition has 248 pages. This growth has been by the addition of new machines and not by elaboration of the matter. How this is done is shown by the list of additions made this year, which include the No. 8 plain milling machine; vertical spindle milling attachment for No. 8 plain milling machine; 13-in. engine lathe; No. 2 automatic screw machine; new arbors for milling machines; new collets for milling machines; new sizes of milling cutters; new sizes of end mills; special miter gear patterns; bevel gear cutters; 10-in. and 12-in. index centers; standard caliper gauges for sizes larger than 3 in.; rubber gauge; new special gear patterns; new sizes of gear cutters; concave and convex cutters with formed teeth; standard angle irons, and others of less importance.

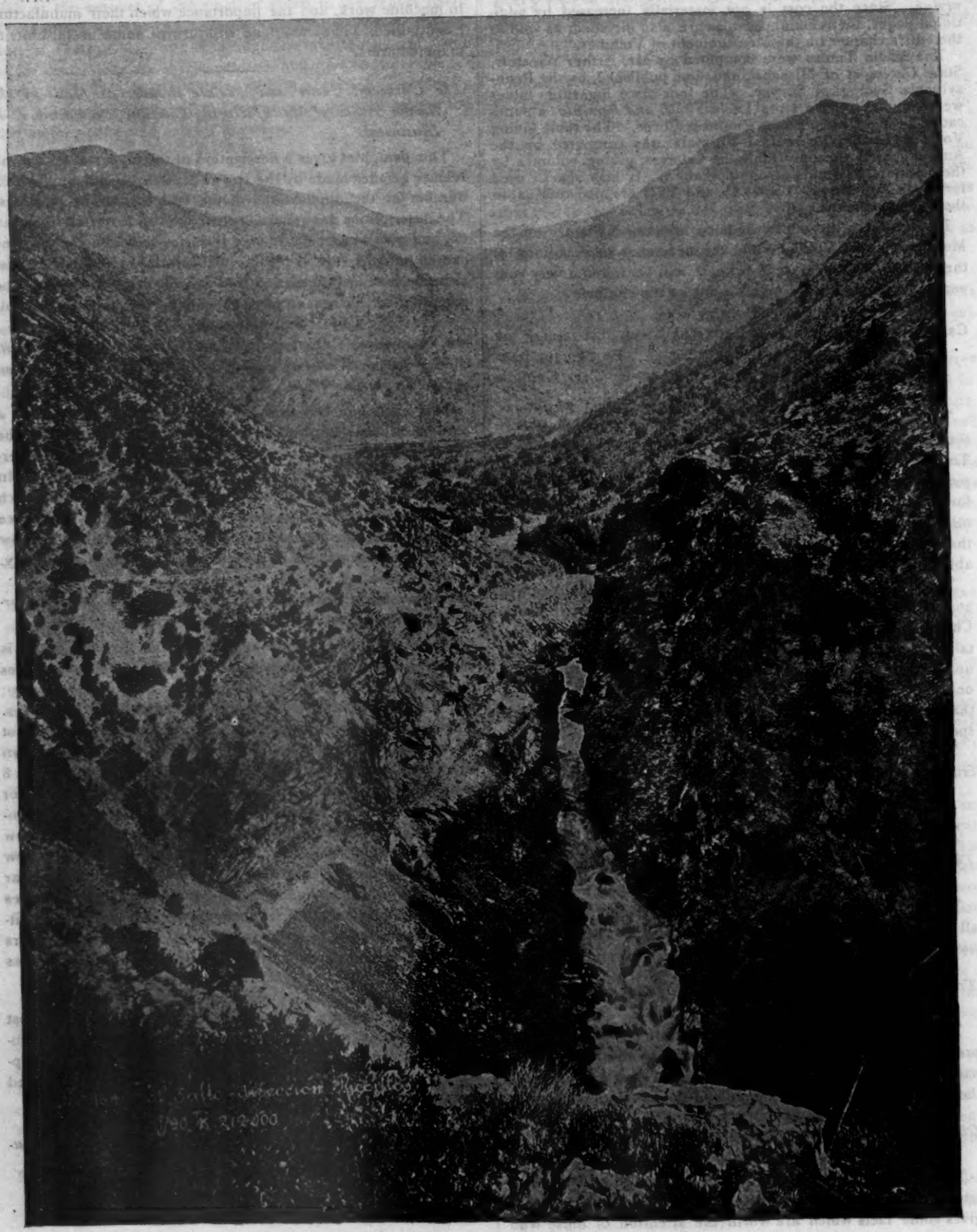
The *Egan Company*, of Cincinnati, has issued one of the most complete catalogues of wood-working machinery ever published. It contains over 500 pages of illustrations and descriptions of a great variety of tools. It is very handsomely printed and the engravings are good.

Price List of Picks, Mattocks, Etc., made by the Columbus Manufacturing Company, Columbus, O.

CURRENT READING.

AMONG the books in press by Houghton, Mifflin & Company is a new and enlarged edition of Mr. Rowland Cox's MANUAL OF TRADE-MARK CASES, an exceedingly useful work for manufacturers and many others.

The MARINE RECORD, of Cleveland, O., has recently enlarged its size and made many improvements in its pages. Our co-



THE TRANSANDINE RAILROAD.—"EL SALTO DEL SOLDATO."

temporary is to be congratulated on these evidences of a well-deserved prosperity. It is an excellent exponent and advocate of the marine interests of the lakes.

The September number of the JOURNAL of the Military Service Institute has a continuation of General Tidball's papers on Artillery Service in the Rebellion; articles on the Terrain in Military Operations, by Captain Pettit; Modern Drill Regulations, by Captain Richards; Organization of Militia Defense, by Captain Chester; Manœuvres and Kriegs-spiel, by Lieutenant Barth; Physical Training of the Enlisted Man, by Lieutenant Harrison; and a number of translations and military notes of interest.

The October number of SCRIBNER'S MAGAZINE gives considerable space to the Columbian Exposition, the leading article being a long one on the building of the great structures for the Exposition, which is accompanied by many illustrations. Another article gives an interesting account of a successful reform school for boys in Paris. The number is altogether one of more than usual interest.

Among the articles in the ENGINEERING MAGAZINE for September are Reflections on the Homestead Strike; Tall Office Buildings; Electric Power in Mining; Effects of Floods in Western Rivers; Making Paper from Wood; the Cotton-seed Oil Industry; Practical Hints on House Heating; and Summer Suburban Communities. The special departments contain some excellent things.

In the POPULAR SCIENCE MONTHLY for October there is an interesting chapter in Meteorological Discovery, by John Coleman Adams. Other articles are on Language and Brain Disease; the Keeley Cure; the Evolution of Dancing; and on Large Cities and the Development of Children.

The October number of the ARENA fully sustains the reputation of that magazine, and contains a number of excellent articles. The reader of this review is always sure of finding something that is worth reading and thinking over.

In the October number of HARPER'S MAGAZINE a large part of the space is given to the commemoration of the discovery of America by Columbus. One of its most valuable articles is a sketch of the life of Columbus, with a critical estimate of his character and services, written by Professor Dr. S. Ruge, of Dresden. This article embodies the results of the latest and most careful researches, and presents the discoverer as he really was, awarding him due praise for his great achievements, while at the same time removing from the story of his life much that may be regarded as purely imaginative. Another article which will attract perhaps even greater attention is the Baptismal Font of America, by Frank H. Mason, narrating the story of the manner in which the Western Continent received its name. It affords some interesting glimpses of life and manners at the beginning of the sixteenth century, and contains a good deal of curious information not hitherto published in popular form. Among the illustrations is a fac-simile of the page in that curious book, the *Cosmographiae Introductio*, in which the name America was first applied to the new world. There are also several portraits and other illustrations.

The September number of OUTING is a bright and refreshing one, containing a variety of articles on canoeing, the bicycle and other outdoor sports. Lieutenant Hamilton concludes in this number his valuable article on the Military Schools of the United States, and there is a great deal of interesting reading in the number.

The October number of the OVERLAND MONTHLY contains a very carefully prepared and fully illustrated article on the University of California, the greatest of Pacific Coast institutions of learning; its history, growth, and present condition are told. The illustrated papers on Pacific Coast scenery are continued by an article by Mabel H. Closson, on a trip to Cook's Inlet, entitled An Alaskan Summer. In addition to these articles there are several excellent sketches and other papers.

In a recent number of HARPER'S WEEKLY an illustrated description of the Brown segmental wire gun and the method of making it was given. The illustration of the Columbian Exposition buildings has been continued in several recent articles.

BOOKS RECEIVED.

Transactions of the American Institute of Electrical Engineers: May and June, 1892. New York; published by the Institute, Ralph W. Pope, Secretary.

The Master Car-Builders' Association and the Contracting Chill. Illustrated, 16 pages. Philadelphia; A. Whitney & Sons.

Report on a System of Protection for the City of Corning, N. Y., from Floods in the Chemung River. By Palmer C. Ricketts, C.E. Corning, N. Y.; the Board of River Commissioners.

Transactions of the American Institute of Mining Engineers. Volume XX.; June, 1891, *to October*, 1891, *inclusive.* New York; published by the Institute, Dr. R. W. Raymond, Secretary.

New South Wales. Report of the Royal Commission of Inquiry into the Alleged Defectiveness and Unsuitability of the Baldwin Locomotives; appointed March 15, 1892. Sydney, New South Wales; Government Printer.

Census of Canada: Bulletin No. 18. *Manufactures and Wages.* Ottawa, Canada; issued by the Department of Agriculture.

Treatise Relative to the Testing of Water-Wheels and Machinery. Fourth Edition, 1892. By James Emerson. Williamsett, Mass.; published by the Author.

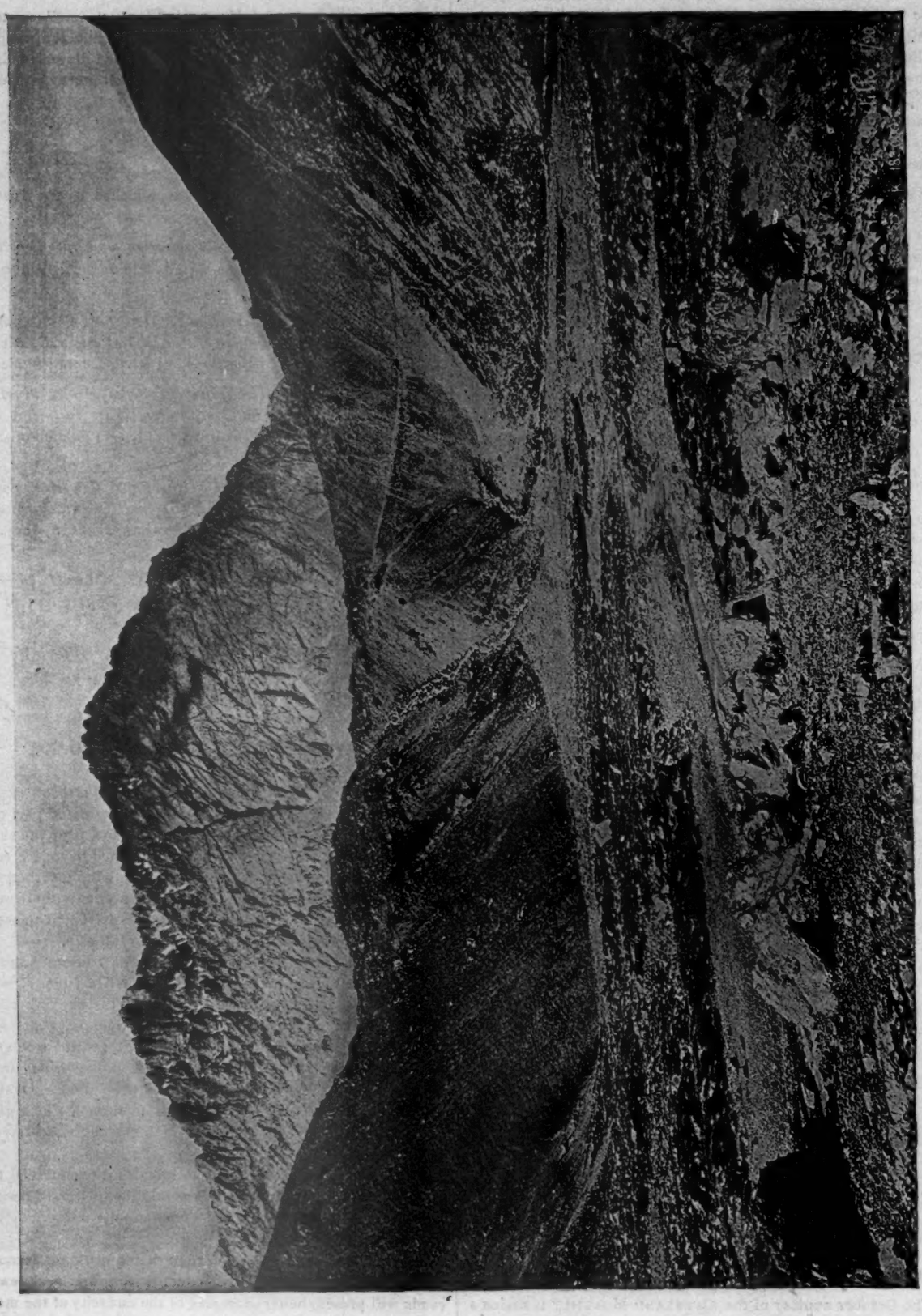
THE TRANSANDINE RAILROAD.

THE work on the Transandine Railroad has been resumed and is now well in progress. By far the greater part of the work still to be done is on the tunnels at and near the summit of the Andes. This work cannot be hastened beyond a certain point, but the contractors intend to use all the most approved appliances in the tunneling. At latest accounts there still remained about 33,100 ft. of headings to be driven, with some of the shorter tunnels still to be enlarged to full size.

On the Argentine side of the mountains construction trains are running to Punta de las Vacas, 87 miles from Mendoza. On the Chilean side the track is laid from the starting point at Santa Rosa de os Andes to El Salto del Soldato, a distance of 23 miles. This leaves 23 miles on the Argentine side and 17 miles on the Chilean side still to be completed, but on both these sections much work has already been done. Of the 40 miles unfinished, nearly one-fourth is in tunnel, which gives a fair idea of the great difficulties which the engineers have had to encounter.

The Transandine Railroad is an important commercial work, and will be the first transcontinental line in South America. There is little doubt that it will command a considerable traffic almost from the first.

Besides this, however, it is a remarkable work on account of the difficulties overcome in its construction, and very few railroads will present better examples of the audacity of the modern engineer. It is not many years since a line across the Andes would have been considered utterly impracticable; but in the present case the engineers have been able to locate and build a



ON THE TRANSANDINE RAILROAD.—"EL PORTILLO," CHILEAN SIDE.

road which can be operated with no more difficulty than many other lines in both South and North America.

The views which are given herewith are from photographs, and are chosen from a number as best illustrating the rugged and savage nature of the country which has required so much costly and difficult work to overcome the difficulties it presents.

SOME CURRENT NOTES.

THE prizes which were offered by the German Railroad Union in 1890 have been awarded as follows: The first prize of 7,500 marks to Herr Von Borries for improvements in compound locomotives; the two prizes of 3,000 marks each, one to George Westinghouse, Jr., for improvements in atmospheric brake, and one to Paul Langbein for an apparatus for transferring cars between standard and narrow-gauge tracks. The six prizes of 1,500 marks each were given to M. Wedler for an apparatus for preventing injury to men working at lathes; to M. Vaolmar for improvements in movable axles; to G. Hautzel for a paper on Track Ballast in its Statical Relations; to Professor Launhardt for a treatise on the Theory of Location; to Railroad Inspector Kolle for a treatise on Apparatus for Protecting Switches and Signals, and to Ludwig Kohlfürst for his book on the Development of Electrical Appliances for Railroads.

It is announced that Mr. Westinghouse has presented the 3,000 marks awarded to him to the German Society of Locomotive Engineers.

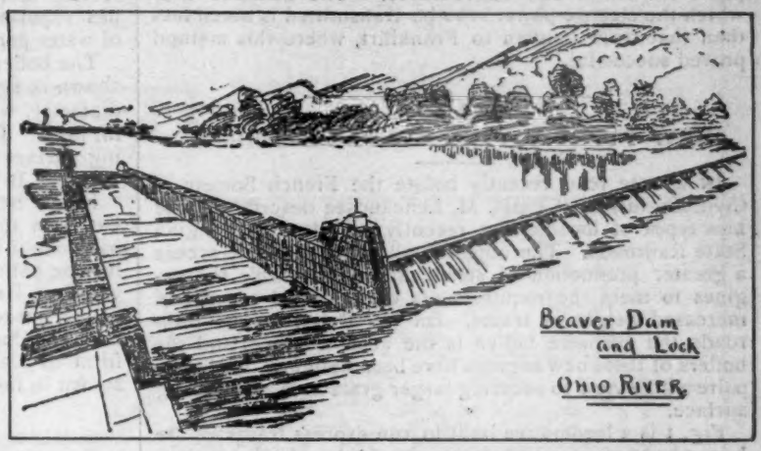
THE White Star Line proposes to surpass the great ships which are under construction for the Cunard Line, and has ordered from Harland & Wolff, of Belfast, a new steamer, which is to be appropriately named *Gigantic*. She is to be 700 ft. long and 66 ft. beam, and is to be able to maintain a speed of 22 knots an hour. She will have three screws, arranged like those of the new cruiser *Columbia*, and each driven by an independent engine. The contract requires this great ship to be finished early in 1894.

THE use of gas engines is by no means so extensive in this country as in England, where they are found at work in many different places. Here they are generally regarded as of service for light work only, and it is with some surprise that we note the advertisement of an English firm, which keeps all sizes up to 40 H.P. in stock, and offers to furnish single engines of any size up to 250 H.P. This much exceeds the capacity of any gas engine built until very recently.

WORK has been begun on the new dam and lock on the Ohio River at Vanport, near Beaver, commonly called the Beaver Dam. This will finally be No. 6 in the series of dams proposed to improve the navigation of the river, of which the Davis Island Dam was the first. The general plan of the dam and lock, as they will appear when finished, is shown in the accompanying sketch, for which we are indebted to the Pittsburgh *Chronicle-Telegraph*.

A special feature is the lock, which has to be adapted to the commerce of the river, and is therefore made very large. The one belonging to the Beaver Dam will be 600 ft. long and 110 ft. wide in the clear, giving an area of 66,000 sq. ft. The lock will permit a towboat, 14 barges and two flats to pass through at the same time. On account of the great size of the lock, several special features will appear. For instance, the miter-gates, ordinarily used for locks, would be too unwieldy for use there, consequently the one adopted is like a Howe truss-bridge laid on its side in such a position as to place the bottom down stream and the top up stream.

The dimensions of the gate will be 118 ft. in length, 13 ft. 6 in. in breadth, and 15 ft. in height. In its passage from the upper to the lower pool the water goes through the upper gate recess; thence it passes by means of seven openings, 4 ft. 6 in. in diameter, into the filling culvert, 9 ft. wide by 13 ft. high. It lies behind the entire length of the lower wall of the upper recess, and then turning sharp to the right it follows the land wall for a distance of 250 ft. In the land wall are built 10 openings 3 ft. × 3 ft. 6 in., through which the water passes from the filling culvert into the lock chamber. From here it passes through the lower recess by means of seven openings similar in size and location to those in the upper recess, into the emptying culvert, whence it flows into the lower pool. The land wall, including the walls of the gate recess, will have a development of 1,170 ft., and will contain about 6,000 yds. of masonry. The river wall will be



690 ft. long and contain about 4,000 yds. of masonry. The Beaver Dam will secure a good boating stage at all times when navigation is not interrupted by ice as far up as the Logstown bar.

There will be a power-house at the dam, containing the necessary machinery for working the gates, regulating the lock and other purposes.

THE railroad from Jaffa to Jerusalem, 54 miles in length, was opened for traffic August 30. It has been built by a French company, the Société Ottomane of Paris, and is of 1 meter gauge. Although a French road in ownership, the locomotives are of the American Mogul type, and were built by the Baldwin Locomotive Works in Philadelphia. One of these engines was described and illustrated in the JOURNAL for December, 1890.

THE Pennsylvania Railroad Company recently ran an experimental freight train through from Chicago to Jersey City without uncoupling and with the same locomotive for the entire run of 912 miles. The train consisted of 40 new 34-ft. box-cars and a caboose car. The cars were all equipped with the Westinghouse brake. They were all fully loaded with grain.

IN a recent paper before the British Association, Professor George Forbes, while advocating the use of destructors for disposing of garbage and city refuse by burning, suggests that the heat produced by the combustion of the garbage may be used to produce steam for running a central electric-lighting station, or a power station. The plan has been tried in one or two English towns with success, a supply of power being obtained from material which had heretofore been entirely wasted, the only object being to get rid of it.

IN Spain it is proposed to build a great dam on the Guadarrama River near Torrelodones, where a fall of about 200 ft. can be obtained. This can be increased to a total of about 1,100 ft. by building a canal 5 miles in length. The power obtained will be used to run dynamos, and will be transmitted to Madrid by wire for use in lighting the city and for other purposes. To equalize the

power and provide a supply of water in the dry season, a canal some 15 miles long will be built to connect Lake Pantano with the Guadarrama, the lake being thus utilized as a storage reservoir.

The plan also includes the use of the water after passing the dam and water-power to supply the city of Madrid and irrigate the country surrounding it. This will be done by clearing out and repairing the ancient Canal del Gasco and extending it to a point near Madrid, where suitable distributing reservoirs can be built. The old canal covers more than half the distance, including the mountain region where construction is most difficult.

The city of Madrid now has a very insufficient water supply, and the new project, it is expected, will much improve its health and convenience. The distance over which the electric power is to be transmitted is much less than that from Lauffen to Frankfürt, where this method proved successful.

NEW TYPES OF THE BELPAIRE BOILER.

In a note read recently before the French Society of Civil Engineers at Paris, M. Lencauchez described some new types of locomotives recently built for the Belgian State Railroads. The object in all of these was to secure a greater production of steam, and thus enable the engines to meet the requirements of increased speed and increased weight of trains. On the Belgian State Railroads the Belpaire boiler is the accepted type, and the boilers of these new engines have been designed by M. Belpaire with a view to securing larger grate area and heating surface.

Fig. 1 is a locomotive built to run express trains on the Luxembourg line, where there are grades of 1.6 per cent. of considerable length. On these lines the express trains have an average weight of 110 tons, and are required to run at an average speed of 37 miles an hour, 46 miles being the maximum allowed. The sketch shows a side elevation and a rear view, while below a cross-section and longitudinal section of the inside fire-box are given. From the latter it will be seen that the fire-box is carried out to the full width allowable, and that it is entirely above the frames and is very shallow in proportion to its width.

This engine has three pairs of coupled wheels 67 in. in diameter and one pair of leading wheels, the journals of the latter running in radial axle-boxes. The cylinders are 19.7 in. in diameter and 23.6 in. stroke. The boiler is 55 in. in diameter, and has 236 tubes 1.97 in. in diameter and 13 ft. 3 in. long. The fire-box is nearly 9 ft. in width, and the grate area is 61.79 sq. ft. The fire-box heating surface is 161.4 sq. ft., and the total heating surface is 1,573.9 sq. ft. The usual working pressure is 150 lbs. The boiler is of steel and the fire-box of copper. The cylinders are inside and are not placed in the smoke-box, but back of the axle of the bearing wheels. The smoke-stack is square in section and tapers from the base to the top.

The total weight of this engine in working order is 117,000 lbs., of which 90,100 lbs. are carried on the coupled wheels. The valve gear is of the Walschaert type.

In some experiments made with one of these engines, using a soft bituminous coal, from 53 lbs. to 57 lbs. were burned per square foot of grate per hour. Their performance on the road has been satisfactory.

Fig. 2. shows a type of engine built to run the heavy express trains on the more level lines, where there are no grades exceeding 0.5 per cent. The trains usually weigh about 150 tons, and the maximum speed is 55 miles an hour. This engine has four coupled wheels 82.7 in. in diameter, with a pair of bearing wheels forward and another under the fire-box. As in fig. 1 the cylinders are inside and the general arrangement is very similar. The cylinders are the same size, 19.7 in. in diameter and 23.6 in. stroke. The main difference is in the boiler and fire-box. The form of the latter is shown in the rear view, and in the smaller views given underneath.

The boiler is 51.2 in. in diameter and has 242 tubes 1.77 in. in diameter and 12 ft. 7½ in. long. The grate area is 50.7 sq. ft.; the fire-box heating surface is 134.6 sq. ft., and the total heating surface 1,342 sq. ft. The usual pressure carried is 150 lbs. The total weight of the engine ready for service is 108,400 lbs., of which 57,750 lbs. are carried on the coupled wheels.

Fig. 3 shows a freight engine designed for the heavy grades of the Luxembourg line, mentioned above. The cylinders are the same size as those of the other engines shown, 19.7 in. in diameter and 23.6 in. stroke. There are three pairs of wheels, all coupled, and 47.2 in. in diameter. The weight of the engine in service is 95,200 lbs., all of which is on the drivers. The work which this engine is called upon to do is to haul trains of 230 tons' weight (exclusive of engine and tender) over grades of 1.6 per cent. at an average speed of 18½ miles an hour. In service and running a trial train of 230 tons, the boiler has vaporized 24,990 lbs. of water per hour, or 19.2 lbs. of water per square foot of heating surface per hour.

The boiler is very similar in form to that of the engine shown in fig. 2. It is somewhat larger, being 55.1 in. in diameter, with 251 tubes 1.77 in. in diameter and 11 ft. 6 in. long. The grate area is 55.4 sq. ft.; the fire-box heating surface is 122 sq. ft., and the total heating surface, 1,299 sq. ft. The usual working pressure is 150 lbs.

It will be noted that in all these engines M. Belpaire has seen the necessity of increasing the grate area, and has done it by making a wide, shallow fire-box, and raising the boiler so as to bring the fire-box entirely above the wheels. He has approached in some respects the Wootten boiler, but to preserve his own characteristic type of boiler he has adopted plans which make a somewhat difficult form to make and stay properly, especially in the plan shown in the first engine.

SOME RAILROAD HISTORY.

An interesting document now before us is a copy of the report of the South Carolina Railroad Company for the six months ending October 1, 1834. The road was not then completed, but a portion of it had been opened and in operation for about four years, and a year or two later the main line from Charleston to Augusta was finished. The contrast between the railroad of nearly sixty years ago and that of to-day is so well brought out that it seems as if some extracts from the pamphlet—which is, very possibly, the only copy still in existence—may be of interest to our readers.

The pamphlet includes the reports of Mr. John Ravenel, the President of the Company, and of Mr. Horatio Allen, the Engineer, both men well known in their day, and both now dead. It gives also in two or three pages of tables the financial statements of the Treasurer and Auditor; these present nothing of especial note except that we find several "negroes" included among the assets of the company, and credited on the balance sheet at their appraised value.

President Ravenel's report speaks of the condition of the road as follows:

Since the meeting in May last two improvements of value have been completed, to wit, a stationary engine, by which the labor and expense of our workshops are greatly reduced, and a depository for the reception of up freight; the arrangement of which facilitates loading, and enables us to forward freight in the order as to time in which it is received. A cotton depository, being under contract, will soon be erected near that just described, when the buildings at Line Street will be appropriated exclusively to the construction, repairs, and protection of engines, cars, etc.

Agreeably with a recommendation approved at the last general meeting, the 1,185 shares, then held by the Company, have been sold and the proceeds applied to the purposes of the Company. The two locomotives then reported as looked for shortly, from Mr. E. Bury, of Liverpool,

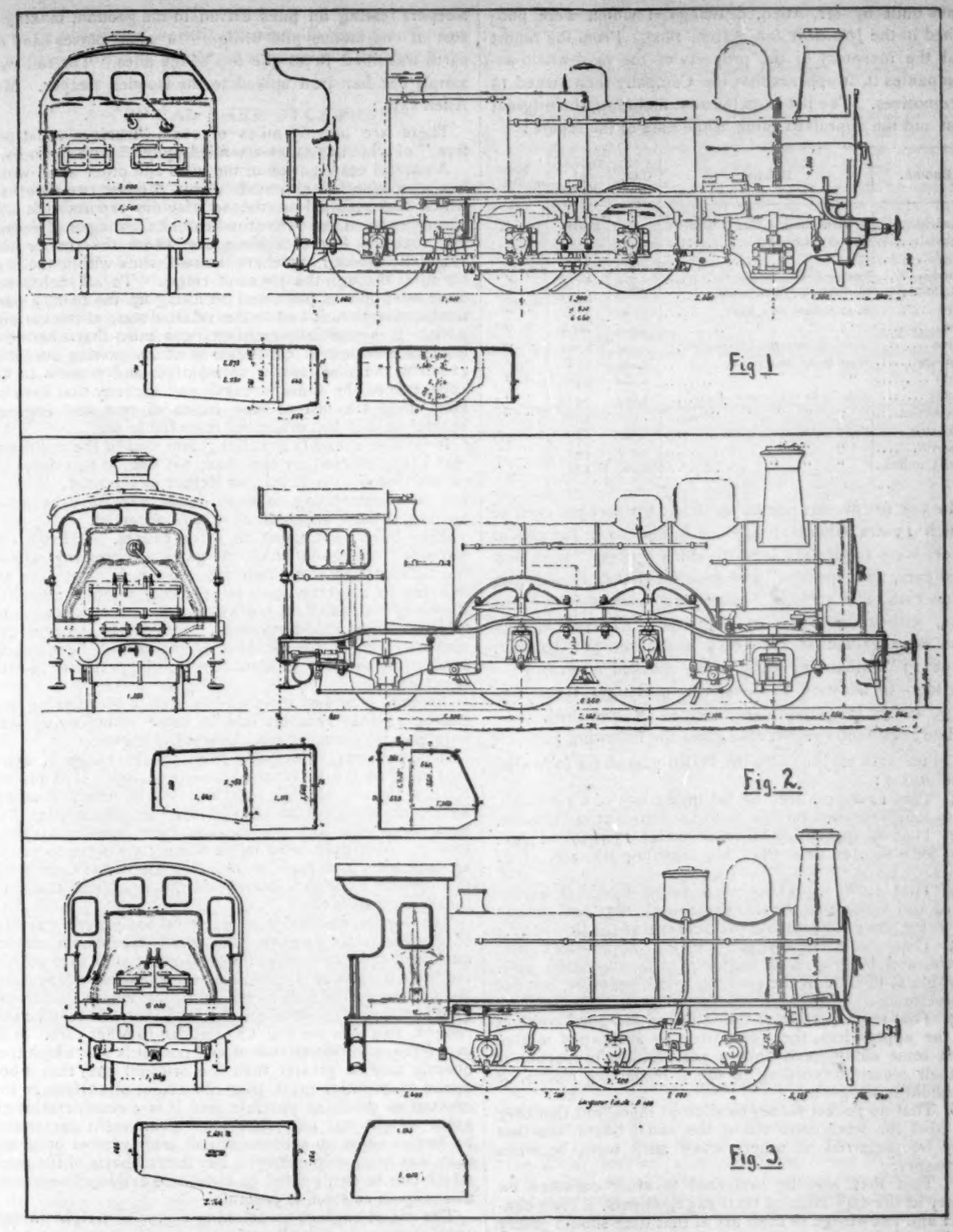


Fig 1

Fig. 2.

Fig. 3.

NEW TYPES OF LOCOMOTIVES, BELGIAN STATE RAILROADS.

arrived on September 9, were immediately placed upon the road, and, we are happy to say, have performed with great profit to the Company and credit to the builder. Four others ordered from England, on March 3 last, are expected soon to arrive, when we shall have ample power for present purposes. In anticipation of a great increase of business, an order for six engines was forwarded on the 4th inst. to William C. Molyneaux, Esq., of Liverpool, to be executed with dispatch, and arrangements are in progress here to convert the boilers and such other parts as are suitable and good of the *Charleston*, *Barnwell* and *South Carolina* into engines upon 4 or 6 wheels. The Board, after much and minute investigation, being of opinion that six durable engines of considerable power can be constructed out of the materials which would otherwise be useless and lost.

Although not so stated directly in the report, it would appear from other portions of it that the three engines which were thus to be rebuilt were the double-truck en-

gines built by Mr. Allen, drawings of which were published in the JOURNAL for March, 1890. From the report and the inventory of the property of the road which accompanies it, it appears that the Company then owned 15 locomotives. The list is as follows, including the original cost and the appraised value at the date of the report:

ENGINE.	Builder.	Cost.	Appraised Value.	Remarks.
Edgefield.....	R. Stephenson & Co., Newcastle	$5,625	$5,000	In use.
Augusta.....	E. Bury, Liverpool.....	5,300	5,300	" "
Georgia.....	" " "	5,300	5,300	" "
Columbia.....	Fenton & Co., Leeds.....	5,915	4,500	" "
E. L. Miller...	M. Baldwin, Philadelphia.....	6,000	5,500	" "
Horry	E. L. Miller, New York.....	5,000	3,000	" "
Aiken	" " "	4,500	1,000	" "
Native.....	Eason & Dotterer, Charleston....	4,900	4,300	" "
Hamburg.....	West Point Association.....	5,000	5,500	" "
Edisto.....	" " "	6,000	3,500	" "
Phœnix	Rebuilt in Co.'s own shop.....	4,000	2,500	" "
Constitution....	(" " " " "	.....	4,000	" "
Charleston.....	Builder not stated).....	6,000	2,500	Laid up.
Barnwell.....	" " "	3,000	1,300	" "
South Carolina..	" " "	3,000	1,000	" "

In the list of cars owned we find 23 passenger cars, of which 13 are valued at $450 each, and 10 at $400 each. There were 149 freight cars, of which 99 were "high covered cars, with springs," and were rated at $225 each; 27 "low cars, with springs," worth $200 each, and 23 "low cars, without springs," at $150 each. Three baggage cars were valued at $250 each and three at $180 each, while 13 "embanking cars" were charged at $1,656 for the lot. In addition to these, two passenger, three baggage, and 72 freight cars are reported as unfinished.

The President's report also gives the following:

On the 27th of June last the Board passed the following resolutions:

1. That 12 apprentices be taken, natives of Charleston, or so long residents therein as to be inured to the climate.

2. That no apprentice be taken under 15 years of age, nor for a shorter time than his reaching the age of 21 years.

2. That each apprentice sign an engagement on his word and honor that he will serve until that age, and do all in his power to promote the interests of the Company.

4. That the Company provide the apprentices with board, and lodging, and washing, or a stipulated sum, payable at the end of the year, on good behavior, but not with clothes.

5. That in proportion to the industry and good conduct of the apprentices, the Committee be authorized to give each some compliment once a year, and to proportion it at their pleasureaccording to the ir respective merits, or withhold it altogether.

6. That no pocket money be allowed them, but that they be paid for work done out of the usual hours, and that they be preferred to others when such work becomes necessary.

7. That they also be preferred to other workmen on salary at the expiration of their engagements, if their conduct and knowledge of their art at that time should justify such employment.

In pursuance of which six youths of character and capacity have been indented, it being designed as soon as they shall have passed through the earlier labors of the art to take six others; by which not only the immediate interests of the Company, but those of the community, will be greatly promoted in the extension of the mechanic arts.

The report of Mr. Horatio Allen, after some brief statements as to contracts, goes on to give some information as to the condition of the road and the experience in operating. It should be noted here that the superstructure, as originally built, consisted of longitudinal wooden sleepers resting on piles driven in the ground, making a sort of continuous pile bridge. In some places sand or earth was filled in to the top of the piles. The rail was simply flat bar iron spiked to the wooden sleeper. Mr. Allen says:

There are now 65 miles of road, "surface construction," of which 27 miles are filled up level with the rails.

A careful examination of the piles and other wood-work has been directed and made within the last two months; which has resulted in the satisfactory reports that apparently almost the entire road exhibits few signs of decay, and that the few exceptions are where the timber was originally inferior, or where the road runs within the first six miles through the dry sand ridges. To all such cases close attention is paid, and in filling up the road, a particular attention is had to the relative state of the various parts. It is especially satisfactory to know that where the road is elevated in consequence of its passing over low grounds, the piles remain unimpaired, and possess to all appearances the same strength and security that have so long stood the test of long trains of cars and engines heavier than it was originally intended to use.

It is also a highly gratifying fact that of the accidents that have occurred on the road, not one, to this day, can be attributed to a failure or defect in the road. It may not be uninteresting to have stated what have been the sources of those accidents that have occurred.

They have been found in three causes. 1. From the improper position in which the gates and crossing rails of the turnsout were in when the engines or cars have attempted to enter or leave the passing places. Such are therefore attributed to the neglect or mismanagement of the attendants at the turnsout. Our efforts and arrangements to remove this source of accidents have been nearly successful, and it is believed they will be hereafter of rare occurrence.

Another source of accident has been in the running one engine against another, and in some instances against animals that cross the road before the engine.

It is, however, principally from the breakage of axles that most of the accidents have originated. It is probable that the use of high cars and elevated loads of cotton have occasioned the breaking of the same sized axles that have previously, with the low cars, been found adequately strong. Measures were taken some time since to guard against such breakage by reducing the loads carried by the present cars and having all the new axles made of larger dimensions.

The breakage of axles on our road has proved a source of greater inconvenience than was expected, in consequence of the structure of the road being such as to permit the broken parts of wheels or axles, when they dropped, to become entangled with them, by which means, as the engine continued to advance, much of the road may be deranged, and thus the evil be extended to other cars. It is in reference to this attendant evil (and it is one which frequently may be greater than the original one) that it becomes of peculiar value that the extent of surface be increased as much as possible, and it is a consideration of great weight not only that the embankment operations be carried on at an earlier day and with greater progress than was originally intended, but that all parts of the road which can be easily filled up should be rendered secure in this respect as soon as possible.

The use of engines occasioning a greater weight in one point than was originally calculated upon has in some instances gradually pressed the iron plates into the wood, and where the timber has been inferior rendered a new surface necessary. This is readily done, and is attended to by the overseers and their assistants.

It may be noted that there are two matters which have not changed much even in 60 years. There are still complaints made of a tendency to increase the weight of locomotives faster than the capacity of the track to support them—which, some critics have insinuated, is due to the fact that mechanical engineers are more progressive than their civil brethren—and also of a disposition to increase

the loads of cars faster than the size of the car axles. It may be added that we still occasionally have trouble arising from "running one locomotive against another."

A TYPICAL LAKE STEAMER.

(From the Cleveland *Marine Record.*)

THE illustration presented herewith of the steel steamer *W. H. Gilbert* will give our readers not connected with the lake marine a fair idea of the steam tonnage now being put afloat by lake ship-builders.

The *W. H. Gilbert* was successfully launched from the yards of F. W. Wheeler & Company, on June 16. She was promptly fitted out and entered into service within a few days after her launch, under the favorable auspices of her owners, the Empire Transportation Company, of Erie, Pa., and under command of Captain Calvin Chamberlain, of St. Clair, Mich.

THE LAKE STEAMER "W. H. GILBERT."

The dimensions of the *Gilbert* are 345 ft. over all, 328 ft. keel, 42½ ft. beam, and 20½ ft. depth of hold. Her engines are of the triple expansion type, diameter of cylinders, 23, 37 and 62 in., by 44-in. piston stroke. Steam is supplied by three 12 × 12½ ft. Scotch type boilers, and the steamer is fitted with the Worthington condensers. An Edison electric light plant furnishes an abundance of power for all purposes, and the steam windlass, capstans and hoisting engines are supplied from the main boilers. On launching, the *Gilbert* showed a mean draft of only 4 ft., a record in construction of such large tonnage which is difficult to duplicate, and proving that the high class of material used in her construction had been placed according to the best skill known in the science of marine architecture. The capacity of the *Gilbert* is 2,820 tons gross and 2,200 tons net. She is provided with nine hatchways, to facilitate loading and discharging, while the deck space sacrificed in the wake of the hatches is amply compensated for in the extra metal used in the sides, and in the continuous deck strakes.

The *Gilbert* is valued at $225,000, and rates A1 in the Inland Lloyd's classification books, and it is stated that she has the finest equipment of any freight steamer on the lakes.

COLUMBIAN EXPOSITION NOTES.

THE exhibit which the Pennsylvania Railroad Company will make at Chicago will include a section of four-track road complete, with a station building. The rails used will be of the new 100-lbs. section, rolled in 60-ft. lengths, and there will be a full equipment of switches and signals. The smaller exhibits will be placed in the station building. On the track a locomotive of the latest pattern will be placed, and near it will be the old *John Bull*, the first locomotive used on the Camden & Amboy Railroad, which had a place at the Centennial Exposition in 1876.

A VERY interesting exhibit in the Transportation Department will be made by the steamship and railroad companies of England. The collection of models of battleships, yachts, cruisers, steamers and merchant vessels will be more complete than was ever before exhibited. The London & Northwestern Railway will send over a complete train of cars headed by a compound locomotive of the Webb three-cylinder type named *Great Britain*. This will afford an opportunity to compare the English compartment cars and sleepers with American coaches. The Great Western Railway will exhibit the locomotive *Lord of the Isles*, which is of 7-ft. gauge; it was designed by Mr. Brunel, and was one of the first used on that road. Several of the railroads will make exhibits showing their signaling systems.

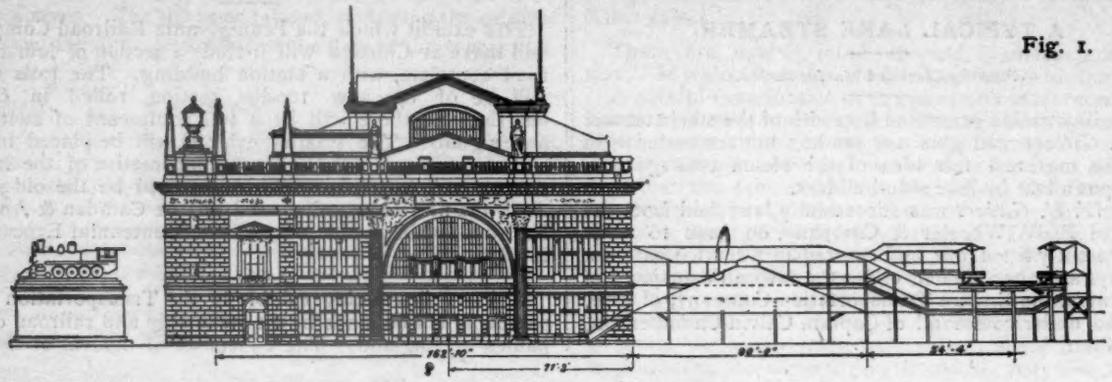
THE Department of Transportation has secured the promise of two large locomotives to adorn the entrance to the passenger station, inside Jackson Park. The Rogers Locomotive Works has agreed to furnish one and the Brooks Locomotive Works the other. Each locomotive will be mounted on a pedestal. They will stand one on each side of the main entrance.

THE accompanying drawings, for which we are indebted

to the *Railway Review*, show the plan for the railroad station on the Exposition grounds; fig. 2 is a plan of the first floor of the station proper, with the inner end of the train-shed, the elevation being shown by fig. 1.

proper. As will be seen by this last-named drawing, the building will present a handsome exterior, fully in keeping in architectural character with the other buildings of the Exposition. To the right of this elevation will be seen the

Fig. 1.



THE RAILROAD STATION AT THE COLUMBIAN EXPOSITION.

As will be seen by the illustration, accommodations for the anticipated crowd are provided on a large scale, the depot building proper being 458 ft. in length by 162 ft. 10 in. in width, the train shed and platform covering a space 672 ft. long. As will be easily seen from the illustration, the interior is laid out with a view of convenience rather than beauty. From the northern entrance admittance is had directly into the main hall, in the center of which and immediately opposite the entrance is located, in the circular space shown, a bureau of information. At the west end of the building opening from this main hall are the men's waiting room, a general waiting hall, check rooms, etc. At the south end is located the ladies' waiting room and a large lunch room. Various rooms for the reception and checking of packages are located throughout the building. At the south side of the main hall numerous openings afford access directly to the train shed; and from thence through a series of stiles shown at the left of the train shed, entrance is had to the track. These tracks are arranged in pairs with wide platforms of 26 and 30 ft. in width between each pair of tracks, which are 48 in number.

location of one of the monumental pedestals and locomotives which are to be furnished by the Brooks and Rogers Locomotive Works respectively. These will be situated on either side of the main east entrance. They are of the mogul type, and are now being constructed especially for this purpose. It is expected that this station will accommodate 25,000 people at one time, and inasmuch as it is to be used exclusively in the excursion train service of the various railroads reaching the grounds, it is ample for the purposes designed, and with the other means of transportation provided will permit a crowd to be quickly handled.

A FULL programme has been prepared for the ceremonies attending the dedication of the Exposition buildings. The first day, Thursday, October 20, will be devoted to a procession, in which all the industries joining in the Exposition will be represented, and there will be many exhibits of a historical character.

This will be preceded, on the evening of October 19, by a reception to distinguished guests, held in the Auditorium.

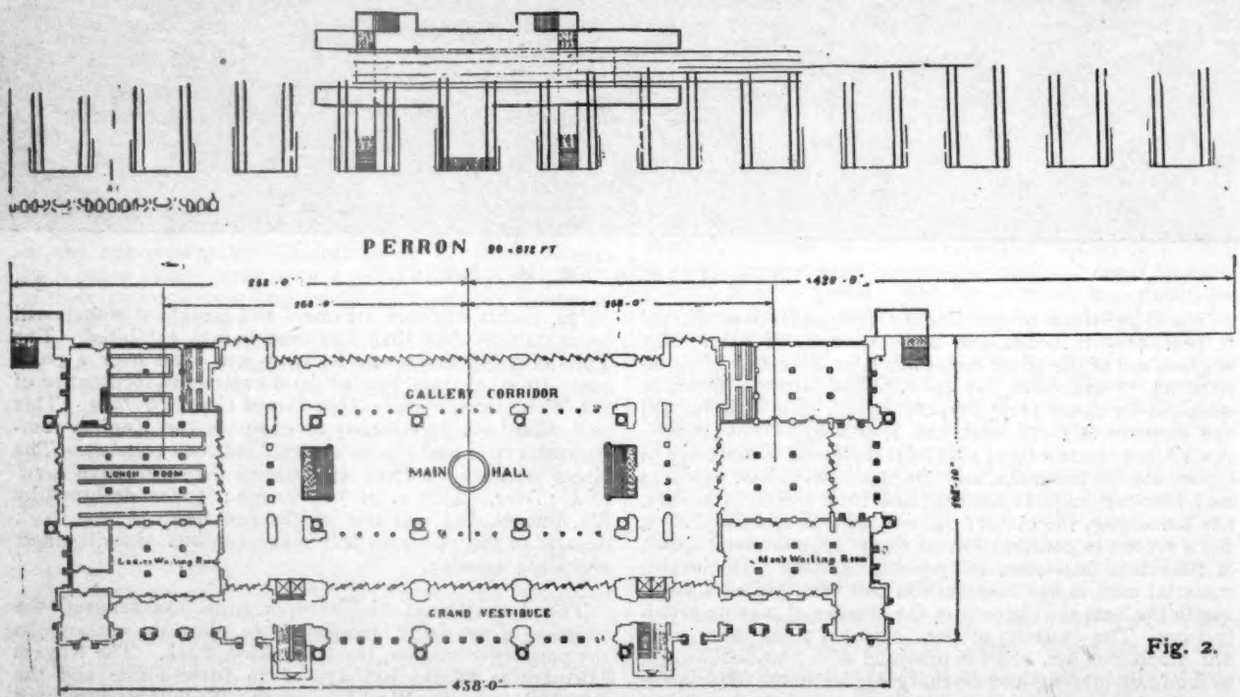


Fig. 2.

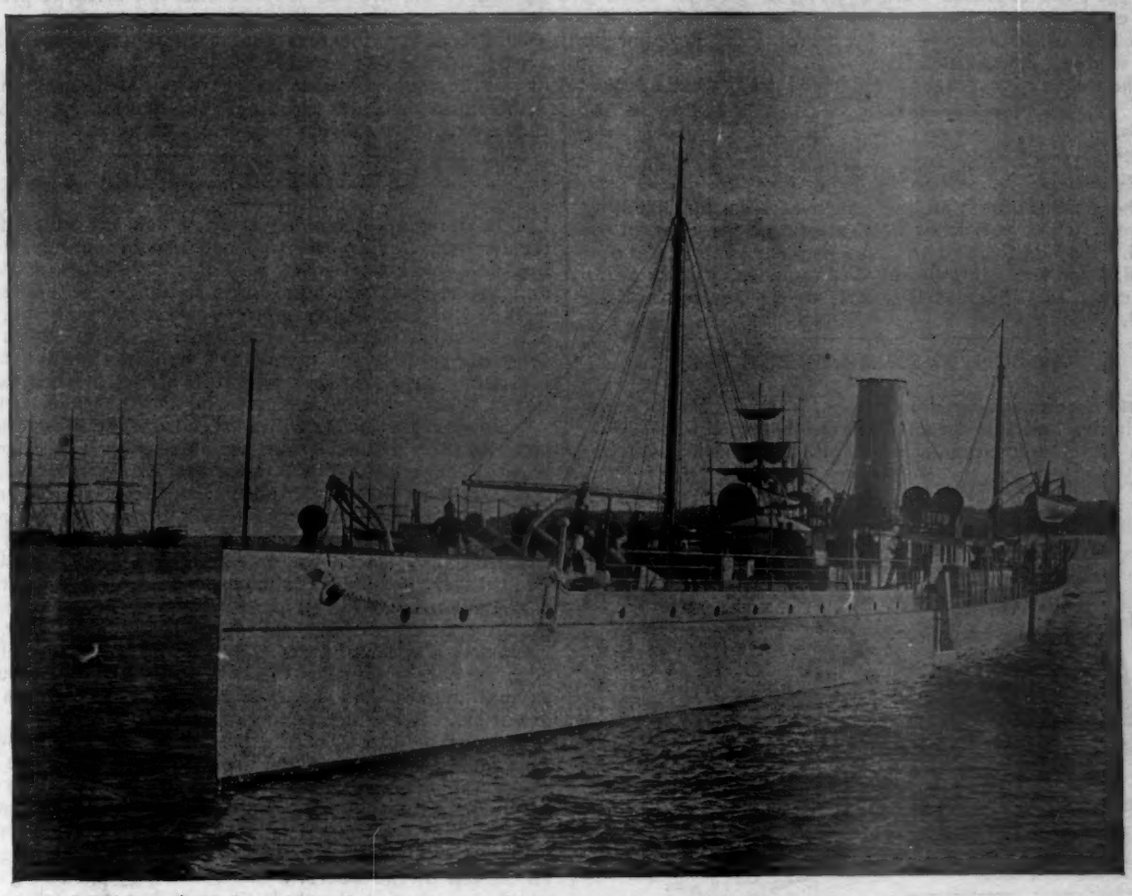
Just above these tracks, as shown in fig. 2, is the terminus of the elevated railroad, the staircases of which appear in the engraving. These terminals are also shown in the other engraving to the right of the north elevation of the station

The actual ceremony of dedication will take place on Friday, October 21, and will be of an elaborate character.

The ceremonies will close with a military parade on Saturday, October 22.

THE DYNAMITE CRUISER "VESUVIUS."

THE accompanying illustration is from a photograph of a vessel whose exact position in the Navy does not seem as yet to be fully determined. The *Vesuvius* was built to carry pneumatic guns discharging shells loaded with dynamite, of the type invented by Captain E. L. Zalinski. Some experiments have been made with the ship which seemed to show that she might be made successful; but they have not been continued, nor has the building of a sister ship been proceeded with, though authorized by law.



THE DYNAMITE CRUISER "VESUVIUS," UNITED STATES NAVY.

The *Vesuvius* differs from all other vessels in the fact that the pneumatic guns are fixed in her hull, and she is in effect a floating gun carriage, the pointing of the projectiles depending entirely upon the movements of the ship. For this purpose, of course, a swift vessel, easily and quickly handled, is required; and these conditions may be said to have been filled in her design.

As to dimensions, the *Vesuvius* is 246 ft. 3 in. long, 26 ft. 6 in. beam, and 14 ft. 1 in. deep; the displacement is 805 tons, with a mean draft of 9 ft. 3 in. The freeboard is thus low, being only about 5 ft. She has two three-bladed screws, each driven by a triple-expansion engine having high-pressure cylinder 21½ in., intermediate, 31 in., and two low-pressure cylinders each 34 in. in diameter; all being 20 in. stroke. There are four locomotive boilers 9 ft. diameter and 19 ft. 8 in. long, with a grate surface of 200 sq. ft. In addition to the propelling engines she is furnished with an electric-light plant and with powerful air-compressors for working the dynamite guns. She can carry 140 tons of coal.

The armament consists of three dynamite guns or pneumatic tubes, which are of 15 in. caliber and are placed abreast at an angle of 16°, the muzzles projecting through the deck at a distance of 37 ft. from the bow. The 15-in. shells will carry 600 lbs. of explosive. The quarters are somewhat confined, owing to the form of the ship, narrow in proportion to her length, and the large amount of machinery which she carries.

The *Vesuvius* was built at the Cramp yards in Philadelphia, and her speed has come fully up to the contract requirements. On her trial trip she attained a mean speed of 21.6 knots an hour, with 160 lbs. boiler pressure and 272 revolutions, a total of 4,450 H.P. being developed.

This vessel has attracted much attention from naval authorities, and it is to be hoped that a fuller series of experiments, which will determine her true value as a war-ship, may be undertaken as soon as possible. At present she is still somewhat of a problem, although she may be considered a success as a fast boat.

COST OF RUNNING A LAKE STEAMER.

AN interesting statement of the cost of running a lake steamer, prepared by Mr. George H. Ely, was recently published by the Cleveland *Marine Review*, and the figures given below are from that paper. The steamer was the *Manola*, owned by the Minnesota Steamship Company, and employed in carrying iron ore. The *Manola* is 308 ft. long over all, 40 ft. beam, and 24 ft. 6 in. deep; she has a triple-expansion engine with cylinders 28 in., 38 in. and 61 in. by 42 in. stroke, and two boilers 14 ft. diameter and 12 ft. 6 in. long. Her average draft is 14 ft. 9 in.

During the season of 1890 this ship was in commission 222 days, of which 175 days were passed in actual sailing, and 47 days in port. She made 30 round trips, and carried 71,171 tons of iron ore, or an average of 2,372 tons per trip. The average time spent in loading was 7½ hours; in unloading, 12 hours. The average time re-

quired for a round trip was 7 days, 9½ hours, the average mileage being 1,686 miles per trip.

The average speed of the ship was 12.72 miles per hour light and 11.85 loaded, and to attain this she burned an average of 209 lbs. of coal per mile light and 226 lbs. when loaded. She carries a crew of 23 men. The total distance traveled during the season was 50,584 miles, and the total ton-mileage of freight carried was 3,600,079. It must be remembered that cargo is carried only one way, the up trip to Lake Superior being made light.

The total earnings of the ship for the season were $93,738; the expenses were $55,114, or 58.8 per cent. of the earnings, and the net earnings were $38,624. She thus earned an average of $422 gross and $174 net per day while in commission.

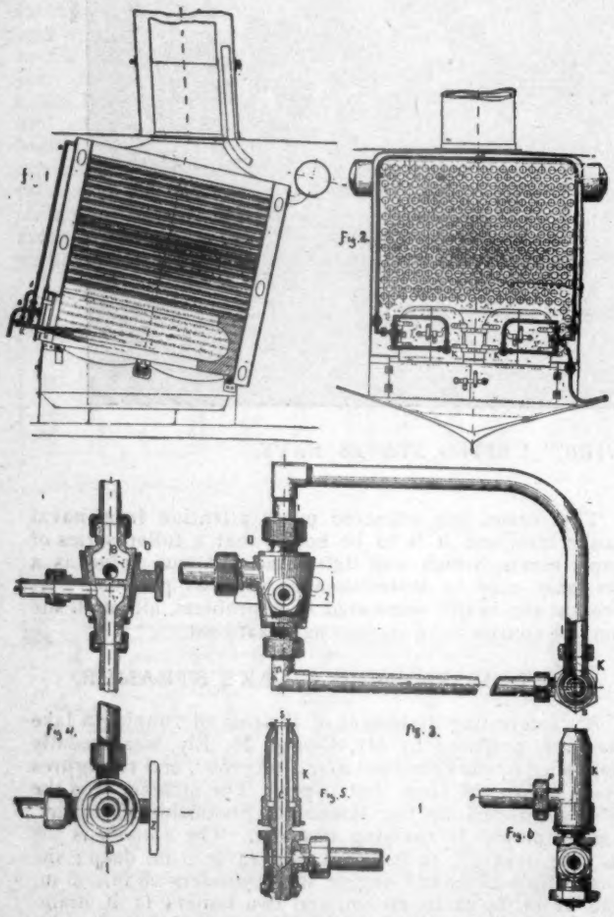
The following averages are derived from these figures:

	Per mile traveled.	Per ton carried.	Per ton mile.
Earnings.....	185.3 cents.	131.7 cents.	0.078 cent.
Expenses.....	109.0 "	77.4 "	0.046 "
Net earnings.	76.3 "	54.3 "	0.032 "

The heaviest item in the expenses was for handling cargoes, which required $16,112, or 29.2 per cent. of the total. Fuel cost $14,427, or 26.2 per cent.; labor, $10 021, or 18.2 per cent.; provisions and supplies, $3,305, or 6.0 per cent., and insurance, $5,471, or 9 9 per cent. of the total.

AN OIL-BURNING FURNACE.

THE accompanying illustrations, from *Le Yacht*, show the boiler and furnace of the French torpedo-boat *Iris*, with which numerous experiments have been made recently in burning oil, with much success. The fuel used was what the Russians call *astatki*—that is, the residuum or heavy oil left after distilling petroleum from the Baku wells.



OIL-BURNING FURNACE, FRENCH TORPEDO-BOAT "IRIS."

In the engravings figs. 1 and 2 show the boiler in section and figs. 3, 4, 5 and 6 the apparatus in detail. This apparatus was put in without removing the grates for burning coal. It consists of an injector or spraying apparatus by which the oil is thrown into the fire-box in a divided state. The tubes *a* and *b* convey the oil to the upper compartment *B* of a distributor *D*, and from this it passes through the pipe *i j l* to the injector *K*. Steam taken from the boiler by the tube *A* is used to force out the oil and distribute it in a spray. The whole method will be readily understood from the drawings. The bottom of the fire-box is lined with fire-brick, to prevent injury from the flame.

In a recent trial it was found that steam was very quickly raised, the fire was very easily controlled, steam was kept at any desired point, and there was hardly any smoke. Analyses of the gases escaping from the chimney showed that the combustion was very nearly complete.

A NEW FIRE-BOX AND GRATE.

THE drawings given herewith, which are taken from the *Portefeuille Economique des Machines*, show a new fire-box and grate devised by M. Cohen, Engineer, of Paris, and which has been applied to a number of boilers in France with excellent results. In these drawings fig. 1 is a longitudinal section of the fire-box; fig. 2 shows the grate in operation as applied to a Belleville boiler; fig. 3 is a front view; fig. 4 a side view of the fire-box, while figs. 5, 6 and 7 are detailed drawings of the grate-bars.

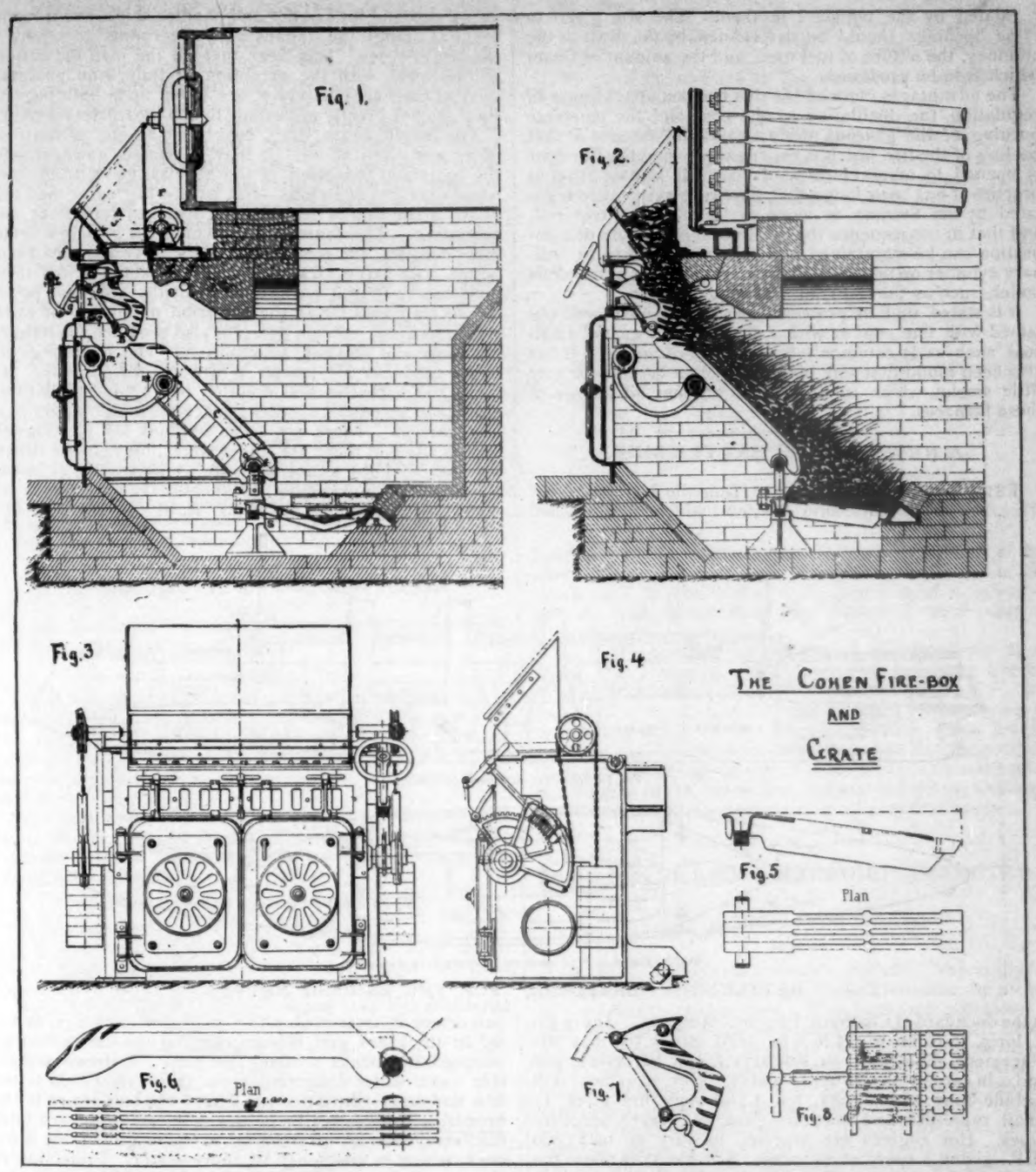
This arrangement, as will be seen from the illustrations, includes three distinct grates surmounted by a feeding apparatus at the top. The large grate, *C*, fig. 1, is inclined at an angle of about 45°, and is formed of cast-iron grate-bars, supported at the bottom by a circular bar or pivot rest, and at the top by another bar, which is carried by two cast-iron arms placed one on each side. The form adopted for these grate-bars is shown in fig. 6. They are made of considerable depth, to permit them to be kept cool by the air entering through the ash-pan. At the upper end they carry a series of lugs, which are intended not only to keep the bars at a proper distance from each other, but to prevent fine coal and coal dust from dropping through before it has been subjected to combustion.

The small grate *D* at the bottom receives the cinders and clinkers formed in the fire, and is supported at one end by the bearer *R*, which serves also to carry the fire brick composing the back of the furnace, and at the other end by the bearer *S*, which is of cast iron and is formed as shown. These bars are also shown in detail in fig. 5. To the top of the bearer *S* is also bolted the bearings, in which are carried the shaft or pivot bar upon which the large grate-bars rest at their lower end.

The upper grate *B* is composed of bars of a peculiar form, one of which is shown on a larger scale in fig. 7. The number of these is, of course, dependent upon the width of the fire-box, and they are arranged so as to be movable, resting upon the pivot *B*. A movement of rotation can be given them by means of the lever *L*, which is outside of the furnace. These bars, it will be seen, have a series of ribs upon their faces, the chief object of which is to prevent the fine coal from falling through. By moving them upon the pivot *B*, it will be seen that the opening through which coal is fed into the furnace can be increased or reduced in size, as may seem to be most expedient.

At the same height as the upper grate there is a fire-brick arch *E*, and upon each side are openings *G G*, by which air can be admitted to the furnace. Air can also enter through the bars of the upper grate by the openings *G* and under the large grate *C* through dampers placed in front of the fire-box, as shown in fig. 3. These series of openings are separated by a diaphragm, so that their regulation is entirely independent of each other.

The whole furnace is enclosed by cast-iron plates, which are lined by fire-brick. At the back end are openings leading under the boiler to the chimney, the size of which is regulated by that of the fire-box. In operation the coal is fed to the fire through the hopper *A* at the top. This has on its face two openings, through which a poker or slice can be introduced to secure the regular descent of



the fuel over the whole width of the grate, and to remove any obstruction. This feeding apparatus is carried upon pivots *f f*, so that it can be thrown back altogether when necessary. The thickness of the layer of fuel allowed to pass through the grate can be regulated by moving the upper grate bars.

Upon feeding, the coal falls first upon the upper grate *B*, and is there submitted to the heat radiated from the arch *E*, which causes a partial distillation, setting free the combustible gases, which are mixed with the air passing through the grate *B* and the openings *G*. This produces a mixture of the volatile matters with the air and puts them into a position ready for active combustion. They are drawn by the draft between the arch *E* and the burning mass of coal upon the grate *C*, and being submitted on both sides to a very high temperature, it is believed that their combustion will be almost perfect. The coal is passed through these processes of distillation, and passes over the bars *B* upon the large grate *C*, and this motion can be hastened by operating the levers *L*. In this way the rate of combustion can be, to a certain extent, regulated, and no more fuel will be thrown upon the grate *C* than can be properly burned. Upon the large grate the coal burns as in the ordinary fire-box, but the mass resting upon the small grate below prevents it from descending too quickly or from falling into the ash-pan until it is completely burned. The cinders and clinkers which fall upon the small grate *C* can easily be removed in the ordinary way.

The two arms which support the shaft *m* and the upper grate *C* are in their turn carried on another shaft *m'*, which passes through the furnace on each side. This shaft can be rotated by means of the sectors placed on each side of the furnace, as shown in figs. 3 and 4. The weight of the grate is counterbalanced by weights supported by chains and pulleys as shown, so that only a slight effort is required to move the shaft *m'*, and therefore to raise or drop the grate.

The doors leading to the ash-pan should usually be kept closed, and the admission of air under the grate can be

regulated by the registers in them. The size given to these openings should be determined by the draft of the chimney, the nature of fuel used, and the amount of steam which is to be produced.

The advantages claimed for this fire-box are the ease of regulation, the distillation of the coal and the complete burning of the gaseous products and the absence of that cooling of the fire which is experienced when the fire-door is opened to admit charges of coal. It is stated that in practice it has been found that the fire is very easily regulated by the fireman as more or less steam is required, and that in consequence the most economical rate of combustion can be maintained. It can be applied to an ordinary cylinder or tubular boiler or to any form of tubulous boiler, such as the Bellville, Babcock or others.

It is stated that in practice best results have been obtained with fine coal or with a mixture of large and small coal, such as is commonly called "run of mine." It has also been found that soft bituminous coal burns with very little smoke, which is claimed as another advantage of these furnaces.

A NEW ENGLISH BATTLE-SHIP.

THE accompanying illustration, from the London *Industries*, shows the battle-ship *Barfleur*, which was launched

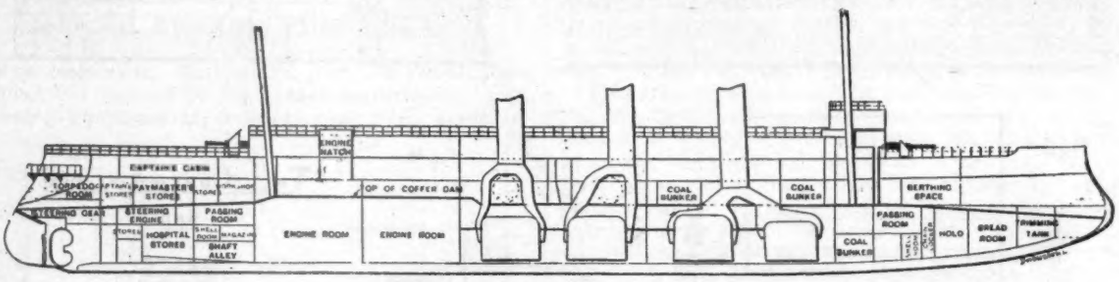


FIG. 1.—SECTIONAL ELEVATION OF VESSEL.

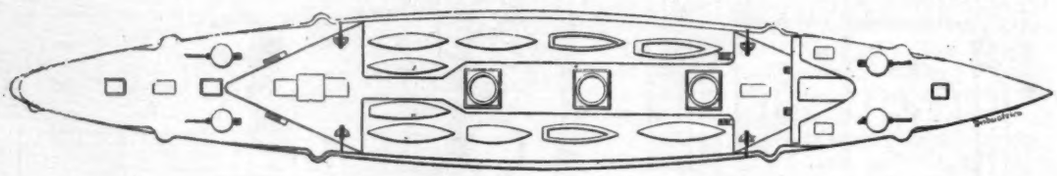


FIG. 2.—GENERAL PLAN SHOWING DISPOSITION OF ARMAMENT.

BATTLE-SHIP "BARFLEUR," FOR THE ENGLISH NAVY.

at the dockyard at Chatham, England, August 8. She is 360 ft. long, 70 ft. beam, 25 ft. 6 in. draft and 10,500 tons displacement. She has 12-in. side armor, 9-in. barbette armor and 4-in. armor on the upper works. Her armament will include four 10-in. guns, ten 4.7-in rapid-fire guns, 17 small rapid-fire and machine guns and seven torpedo-tubes. Her engines are expected to work up to 13,000 H.P., giving a speed of 18 knots. She has thus about the same displacement as the *Indiana*, *Massachusetts* and *Oregon*, now building for our own Navy, with somewhat lighter armor, but heavier engines.

The *Barfleur* is one of the two smaller battle-ships which were included in the English naval programme for 1889. She is a distinct retrogression, so far as regards displacement and size of armament upon the *Nile* and *Trafalgar*, and upon other battle-ships which preceded her, but in other respects she possesses attributes which give her superiority over any vessels of this character which have been previously launched, and she and her sister vessel form the first two of a prospective series which are anxiously looked for by some of the greatest nautical experts of the United Kingdom. In speed, gun command, and handiness, she surpasses any battle-ship hitherto afloat in the British Navy. The immense importance which attaches to this smaller class of iron-clad has been recognized in England, America, Germany, France, Russia and Spain. In each of these several countries the most recent steel-clad vessels are of moderate dimensions. Italy is the only country which has not responded to the almost universal demand for smaller and handier ships, and it would seem as though the Italians were determined to adhere to the larger types. It is clear that all the civilized nations of the world, with the exception of Italy, who possess a navy of considerable power, are intent upon building battle-ships not greatly exceeding 10,000 tons displacement.

The length, beam, draft, coal capacity, etc., of the *Barfleur* are given above. It may be stated, however, that the command possessed by the heaviest guns, 10-in. steel breech-loaders of 29 tons—viz., 25 ft.—is greater than that of any other ship of her class. This is an important consideration. The four guns, of which the principal armament consists, are mounted in pairs in two armored barbettes, with large arcs of horizontal training. All these guns can be fought on either broadside. Manual power can be employed for all the operation of loading or working these guns. Steam power is also provided for training the guns and hoisting ammunition. The mountings are being made by Sir Joseph Whitworth & Company. Between the barbettes are mounted two 4.7-in. quick-firing guns, and seventeen smaller guns, 6-pdrs. and 3-pdrs., are also carried. There are seven stations for ejecting torpedoes; two of these are under water, four on the broadside behind light armor, and one at the stern. A belt of armor having a maximum thickness of 12 in. protects the water-line region for about 200 ft. of the length. This belt armor is associated with a protective deck 2 in. to 2½ in. in thickness, and is completed at the extremities by armored bulkheads crossing the ship. A strong protective under-water deck runs from these bulkheads to the bow and stern respectively. Above the belt armor to the broadside is protected by light armor equivalent to a total thickness of 4 in. of steel up to the height of the main deck, which is about 9¼ ft. above water. Protection is also given to the quick-firing guns and their crews by revolving shields in fixed casemates. The hull is of steel, built on the system usually followed in the English Navy, and is minutely subdivided. Steel armor, made by Messrs. Vickers, is fitted on hull and barbettes. Wood and copper sheathing are fitted on the bottom, to prevent fouling and consequent loss of speed after long periods afloat. The ship is thus especially adapted for service on foreign stations. She is of light draft, as compared with most battle-ships of her size, and will be able to pass through the Suez Canal with a large quantity of coal on board, being in all other respects fully laden. Relatively high speed is arrived at in the design, and larger and heavier boilers than have hitherto been fitted in battle-ships have been provided, so as to secure the maintenance of speed on long distance steaming. The engines are by the Greenock Foundry Company.

The framing of the *Barfleur* is very strong. The double bottom extends right up to the armor shelf, and the depth of the web between the flanges of the framing is very great. Arched stiffeners are placed also behind the thick

and light armor, and the coal bunkers are associated with these. The midship section is very flat across the floor. The arrangements for isolating the guns and gun crews between decks are very complete. The four 4.7-in. quick-firers in this position are provided with splinter-proof casemates of 2-in. steel, and on the outside are sponson ports, also of steel armor, which rise from the summit of the thin 4-in. steel side-armor before alluded to. There are ready-service magazines also associated with each position, into which the ammunition is served from the magazines below, and the connections between these and the casemates are armored.

The strong points claimed for the *Barfleur* as compared with corresponding iron-clads of other nations are as follows: Her speed, which will probably exceed 18¼ knots, is greater than that of any ship of her class now building, excepting the armored cruiser of Spain. The draft is very small, which will enable her to pursue the enemy into shallow harbors. The coal capacity is greater than that of any ship of the class, except those of the United States. The 4.7-in. quick-firers are of greater caliber than any others. Last, but certainly not least, there is an alternative arrangement for working the heavy guns by hand in the event of the hydraulic or steam machinery breaking down. We must not, however, fail to observe that Spain will shortly have eight of these handy armored vessels, all of greater speed and possessing heavier armament than that of the *Barfleur* and *Centurion*.

THE LOCOMOTIVE PROBLEM AGAIN.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Several answers were received to this and were published in the July and August numbers of the JOURNAL; since then some additional replies have been sent in, which are given below:

VI.—BY SETH PRATT, ASSYRIA, MICH.

Draw $A\,H$ and $B\,K$ parallel to $C\,D$, fig. 5.

It is plain that the crank-pins, when at the *highest* and *lowest* points, as at A and B, have the greatest and least forward and backward motions respectively.

Now, for an instant, these motions may be considered

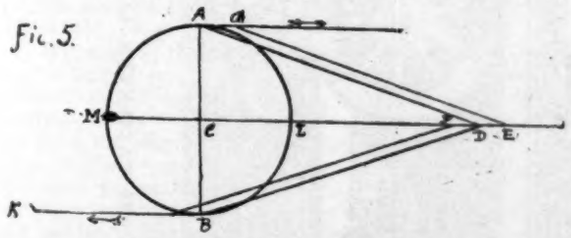


Fig. 5.

as moving in the lines $A\,H$ and $B\,K$, and within very small limits; the lines $G\,E$ and $A\,D$ may be considered as equal and parallel, and consequently the sides $A\,G$ and $D\,E$ are equal. These parallelograms will diminish for equal minute times of the motion of the crank-pin, until it reaches the dead points L and M, where they vanish and the motion of the pin is perpendicular, and they begin to increase until the pin arrives at B, when the maximum retrograde motion occurs.

It may be seen, also, that the greatest effect on the piston is when the angle $A\,D\,C$ suffers the least change, and this happens when the motion of the pin is parallel to that of the locomotive, or at the points A and B, the maximum points of forward and backward motion respectively.

Putting R = the radius of the wheel $= 3\frac{1}{2}$ ft.
r = the distance of the crank-pin from the center,

We have

$$R : R \pm r :: 60 \text{ miles} : 60\,\frac{(R \pm r)}{R} = \begin{cases} 77\frac{1}{7} = \text{maximum} \\ 42\frac{6}{7} = \text{minimum.} \end{cases}$$

This gives $77\frac{1}{7}$ and $42\frac{6}{7}$ as the maximum and minimum respectively.

VII.—BY G. W. MACCORD, HOBOKEN, N. J.

In relation to the "Locomotive Problem," it may be pointed out that when the crank is vertical, as at $C\,P$, fig. 6, and also when it has the position $C\,D$ such that the pro-

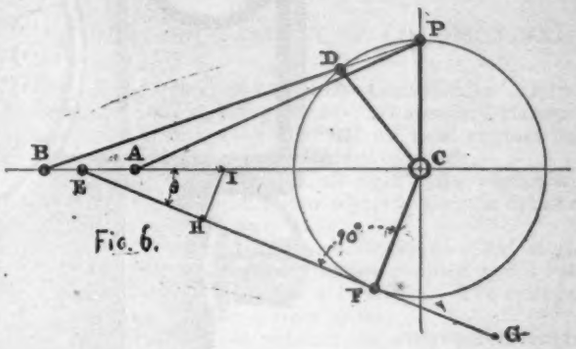


Fig. 6.

longation of the connecting-rod $B\,D$ passes through P, the speed of the piston in the cylinder is equal to that of the crank-pin. In the intermediate positions, it is *greater*, and not less, as stated by Mr. Walker in your issue of August.

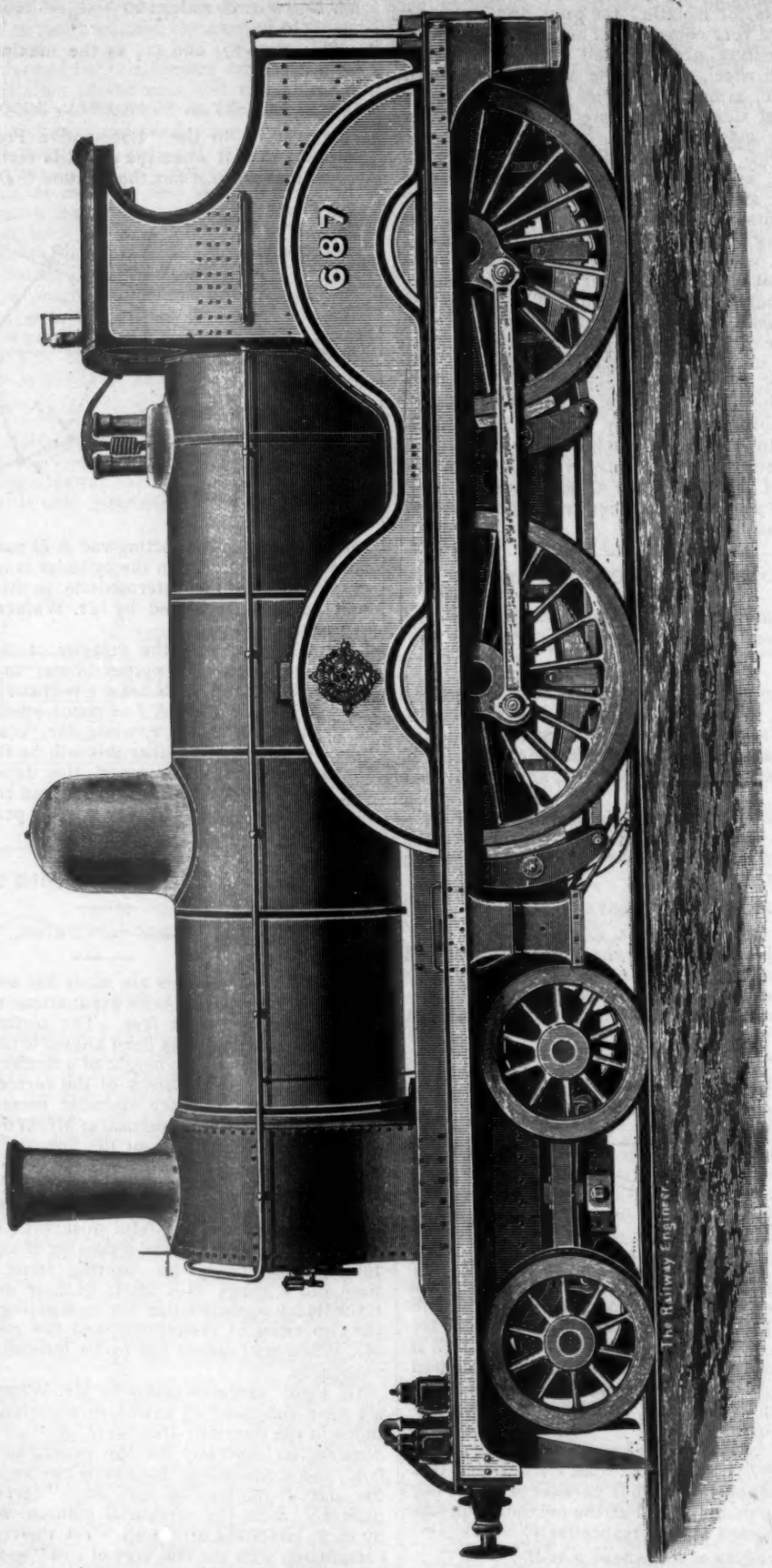
Let $F\,G$ represent the velocity of the crank-pin at F, where the crank is perpendicular to the rod. Set off $E\,H = F\,G$, and at H draw a perpendicular to $E\,F$, cutting $E\,C$ in I; then $E\,I$ = piston-speed. This is equal to crank-speed $\times$ *sec.* θ, while Mr. Walker gives crank-speed $\times$ *cos.* θ. Whether this will be the *precise* position for the maximum piston-speed, also, depends upon the relative lengths of the connecting-rod and the crank, although it will probably be very near it in all practical cases.

SOME NOTES ABOUT ANEROID BAROMETERS.

BY GEORGE L. CUMINE, C.E.

ANEROID barometers are made and sold "especially for the use of engineers," with graduations reading, by means of a vernier, to single feet. The fortunate possessor of such an instrument has been known to triumphantly measure barometrically the height of a drafting-table above the floor; but the refinements of the vernier fail too often to reduce the error in more extended measurements below a serious percentage. A perusal of Mr. Whymper's "Travels Among the Great Andes of the Equator" sheds a light on the dark places of many past barometric experiences, and affords what is probably the most valuable account of the aneroid's behavior at high altitudes yet written. The successful transport and careful observation of two standard mercurial barometers and a number of high-class aneroids throughout journeyings covering some seven months of time and a range of altitude of four miles, afforded extraordinary opportunities for comparing the behavior of the two types of instrument, and the results, as given by Mr. Whymper, cannot fail to be interesting to engineers especially.

Of eight aneroids taken by Mr. Whymper to Ecuador, six were subjected to extensive experiments at high altitudes in the interior; they were all "picked instruments, constructed expressly for the expedition," were "under trial and examination for nearly twelve months" prior to the start from London, and had "corresponded almost perfectly" with the mercurial column, when tested, inch by inch, under the air pump. Yet their performances, in comparison with the readings of two "mountain mercurial barometers of the Fortin type," for some time confounded Mr. Whymper and led him to believe that his aneroids



EXPRESS PASSENGER LOCOMOTIVE. MANCHESTER, SHEFFIELD & LINCOLNSHIRE RAILWAY.

were a bad lot. How he afterward, by a series of experiments in the workshop and comparisons of different readings, arrived at a different and more satisfactory result, is set forth in his pamphlet "How to Use the Aneroid Barometer." What follows here is culled from the book of travels first mentioned.

On the journey out to Ecuador the instruments began to differ among themselves, but the characteristics of the aneroid are best shown by some account of what occurred subsequent to the commencement of the journey into the interior. From the table, pages 412–15 of the "Travels," it appears that on December 10–12, 1879, at Guayaquil, the mean reading of eight aneroids was 29.769, when that of the mercurial barometer, reduced to 32° Fahr., was 29.824; and that on December 17, at Tambo Gobierno, the mean of the aneroids was 20.272, when the mercurial barometer gave 20.759. Thus in five to seven days a change of pressure of about 9½ in. increased the mean error of the aneroids from —0.055 to —0.487. Again, at Guaranda, during the space of seven days, the mean error of the aneroids increased from —0.520 to —0.655, and on December 30, at the second camp on Chimborazo, the mercury standing at 16.480 in., the mean error of the aneroids was —0.903. Ten days later, at this same camp, the mean error of four aneroids observed was —1.096.

The tables show that the greatest difference among the aneroids themselves generally exceeded their mean error; but an examination of the text shows that not a single aneroid fulfilled the promise of the air-pump test; thus, of two taken to the summit of Chimborazo, both presented errors exceeding an inch, and their mean reading was 12.975, while the mercury stood at 14.100, showing a difference corresponding to about 2,000 ft. of altitude.

Some of Mr. Whymper's conclusions may be summarized thus:

At diminished pressures (high altitudes) the aneroid always indicates a lower pressure (higher altitude) than the truth. When the instrument is continually subjected to diminished pressures the error continues to augment for several weeks. On restoration of the pressure the error diminishes, disappears, or changes its sign, this recovery usually occupying a longer time than that during which the instrument was subjected to the diminished pressure. Both the taking on of the error and the recovery are gradual processes, of which the first stages are the most rapid. Different instruments will develop different index-errors under similar conditions, and the amount of the error in each individual instrument will depend on the length of exposure to diminished pressure, and the extent of reduction in pressure.

The ordinary air-pump test is misleading on account of its brief duration. A "good return" to sea-level pressure after an inland journey is not necessarily proof of correct indications at high altitude on the journey.

It is consoling that Mr. Whymper does not consider the aneroid disqualified for closely approximating to differences of elevation in the diminished pressures of high altitudes, especially when the points compared are rapidly accessible one from the other. He recommends using the mean of ascending and descending rather than of several ascending or several descending observations. He describes a satisfactory experiment made with two aneroids, both of which had serious index errors, but which both gave close approximations to the truth. The difference in elevation was about 3,000 ft., and the time occupied in passing from point to point was two and a half hours. In another experiment four aneroids were carried from Quito (elevation, 9,350 ft.) up to the top of an adjoining hill and down again; of the four, three gave ascending and descending readings, differing the one from the other by, in each case, 80 ft., while the fourth gave ascending and descending readings differing by 60 ft.; the mean of the eight readings was 651¼ ft., while careful measurements with the mercury had previously given 657 ft.

To the present writer Mr. Whymper's experiences appear to teach the importance of determining, so far as the aneroid is depended on, the height of a distant inland station—not by simultaneous comparisons extending over considerable periods of time of two instruments, one at sea-level, the other at the station, but from the algebraic sum of the links in a chain of results, each link being a difference in altitude deduced from readings immediately preceding and following an uninterrupted movement of the instrument at the utmost practicable speed; the joints in the chain representing points and times when the instrument was, from any cause, stationary.

It need hardly be added that all interested in the matter are advised to study Mr. Whymper's pamphlet for a full account of many interesting experiments and for deductions therefrom by the person best qualified to draw them.

AN ENGLISH PASSENGER LOCOMOTIVE.

THE Manchester, Sheffield & Lincolnshire Railway Company some time ago adopted four standard classes of locomotives to suit its traffic, and all new engines built conform to these standards. The classes are:

1. For fast passenger travel, an eight-wheel engine with four drivers coupled and a four-wheel truck, the cylinders 18 × 26 in. and the drivers 81 in.

2. For local passenger service, an eight-wheel engine with side tanks, having four drivers coupled and a bearing-axle at each end with radial bearings. The cylinders are 18 × 24 in. and the drivers 67 in.

3. For special freight service, an eight-wheel engine with side tanks, having six drivers coupled and a trailing-axle with radial bearings. The cylinders are 18 × 26 in. and the drivers 61 in.

4. For ordinary freight service, a six-wheel engine with all the wheels coupled and a separate tender. The cylinders are 18 × 26 in. and the drivers 61 in.

The accompanying illustration, for which we are indebted to the *Railway Engineer*, shows an engine of the first class, intended for fast passenger service. It has all the usual features of an English engine of this class, including copper fire-box, plate-frame, etc. The cylinders are inside.

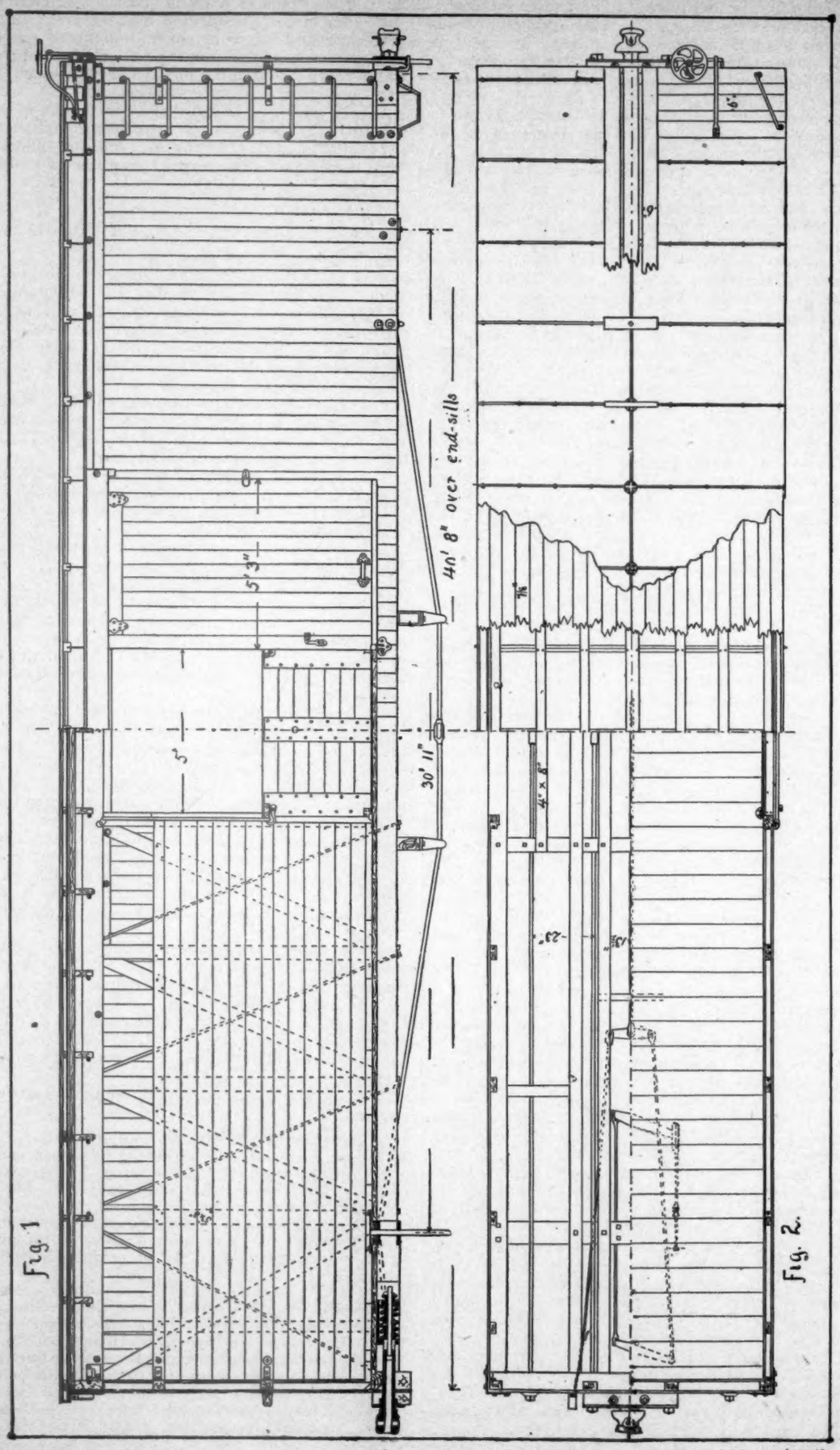
The boiler is 51 in. diameter of barrel, and has 233 tubes 1¾ in. in diameter and 11 ft. 0⅝ in. long. The fire-box is 64⅝ × 42 in. The grate area is 18.85 sq. ft. The heating surface is: Fire-box, 99; tubes, 1,179; total, 1,278 sq. ft. The chimney is 15½ in. diameter; the blast-pipe nozzle, 4¼ in. The usual working pressure is 160 lbs.

The frames are of steel plate 1 1/16 in. thick. The driving-axles have 8½ × 7½-in. journals and the truck-axles, 6½ × 6½ in. The truck has a plate-frame, and the axles are spaced 5 ft. 9 in. apart. The truck wheels are 42 in. in diameter. The driving-wheels are 81 in. in diameter. The driving-wheel-base is 8 ft. 7 in., and the total wheel-base, 21 ft. 9 in.

The cylinders are inside and the steam-chests are on the side, facing each other. The cylinders are 18 in. in diameter and 26 in. stroke. The steam ports are 16 × 1⅝ in. and the exhaust-ports 16 × 2¾ in. The valves have 1 in. outside lap and 4 1/16 in. maximum travel. The valve-gear is the ordinary shifting link. The eccentrics have 6¼ in. throw. The valves are reversed by a wheel and screw-motion.

The *Railway Engineer* says of the performance of these engines:

> On this road the gradients are long and severe. The line is trying for a locomotive, on account of its sinuous nature (some of the curves being only 7 chains radius) and the extra flange friction, which, therefore, has to be overcome. But it is over this line that the engines make such excellent time—Manchester to Retford, 64½ miles in 93 minutes, or to Grantham, 98 miles in 133 minutes; and in the other direction in 101 minutes and 131 minutes respectively. All these times include several stoppages.
>
> The weight of these trains is great, as they constitute the fast service between Manchester and King's Cross, and they all have on heavy 12-wheeled dining and other saloon carriages. The dining cars weigh from 30 to 35 tons, but the weight of these trains over this section may be taken at from 120 to 220 tons, exclusive of the engine and tender, and the consumption of coal on the engines doing this work at from 22½ to 26 lbs. per mile. These engines also work the express Cheshire lines service between Liverpool and Manchester—34 miles in 40 minutes.



STANDARD FURNITURE BOX CAR, MISSOURI PACIFIC RAILROAD.

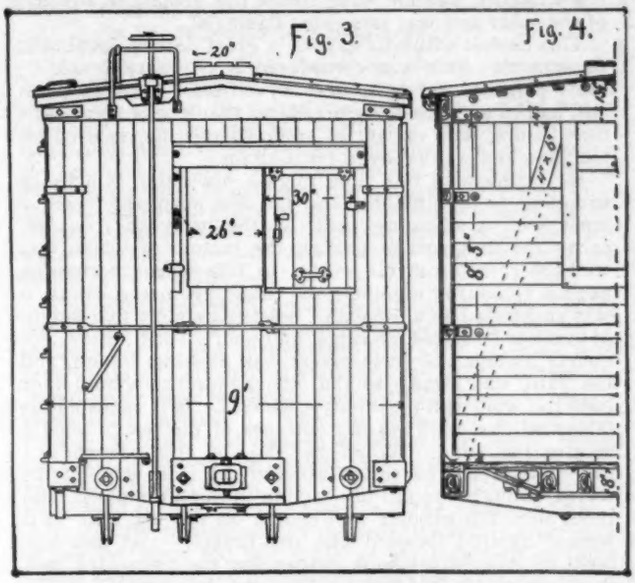
This engine has the vacuum brake, and is fitted with Gresham & Holt's steam-sanding apparatus. The boiler is fed by two Gresham injectors.

The total weight of the engine in working order is 103,040 lbs., of which 71,792 lbs. are carried on the four drivers and 31,248 lbs. on the truck.

The tank will carry 3,080 gallons of water. The tender is carried on six 45-in. wheels, and weighs 78,400 lbs., with a full load of water and coal.

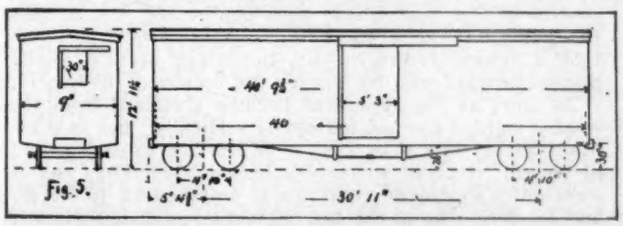
A STANDARD BOX CAR.

THE accompanying drawings show the standard furniture and buggy car of the Missouri Pacific Railroad, which, being intended for light and bulky freight, is of somewhat greater size than the ordinary box and grain car of the road. Fig. 1 is a longitudinal view, one-half in side



elevation and one-half in section; fig. 2 is a plan, one-half showing the floor and bottom framing, the other half the roof, a portion being broken away to show the roof timbers; fig. 3 is an end view; fig. 4 a cross-section; fig. 5 is a sketch showing the general dimensions.

The drawings are complete, and very little description is needed. The material used in these cars is of the best



quality of oak and pine. The cars have the Dunham car door, the McGuire grain door and the Murphy steel roof. The draw-bars are malleable iron, of the standard pattern of the road. The brakes are hand brakes, also of the standard pattern; the steps and running-board are made to comply with the standard requirements.

The trucks—not shown in the drawing—are of the pattern in use for all freight cars on this road, which was described and illustrated in the June number of the JOURNAL. They have 33-in. chilled wheels.

These cars are 40 ft. long inside, and the doors have 5 ft. clear opening, giving them a large capacity for furniture and similar freight. They are rated at 40,000 lbs. capacity, but will carry more on occasion. A large number are in use on the road, heavy orders for cars of this type having recently been filled by the St. Charles Car Company and other car works. The rolling stock of this road has been much improved in recent years, and is being gradually brought to conform with the standard types which have been adopted.

These cars were designed under the supervision of Mr. Frank Rearden, Superintendent of the Locomotive and Car Department. They are a very good example of recent practise in car building.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page 409.*)

THE writer of this record of "Progress in Flying Machines" originally hesitated whether he should include therein the account of the experiments of Captain *Le Bris*, which is about to follow. Not because he deemed it incredible in itself, nor because, if correctly stated, the experiments were not most interesting and instructive, but because the only account of them which he had been able to procure was contained in a novel, in which the author, to make the book more attractive, had mixed up a love story with the record of the aerial experiments, which combination, in the present state of disbelief, the writer feared might be too much for the credulity of the reader. It is true that the author of the novel* said that the account of the experiments was scrupulously correct, and that in this, the principal object of the book, he had endeavored to be very exact, even at the risk of detracting from his hero. It is also a fact that the *Aéronaute*,† in reviewing the book, said:

> Throughout the novel are to be found absolutely historical data concerning the artificial bird of *Le Bris*, his experiments, his partial success, his mischances, and his deplorable final failure, the latter not through a radical defect, but through lack of method, steadiness in thought, and attention to details.

But still the writer hesitated to reproduce this tale of an ancient mariner.

Fortunately, after a year's seeking, he succeeded in getting a copy of an historical book, now quite out of print, by the same author,‡ which gives without any embellishments an account of Captain *Le Bris's* experiments, and quite confirms that given in the novel, wherein it is said to have been related "with scrupulous exactness." From the historical work, therefore, of M. de la Landelle, supplemented by his novel, the following account has been compiled of what seems to have been a very remarkable series of experiments on "aspiration."

Captain *Le Bris* was a French mariner, who had in his younger days made several voyages around the Cape of Good Hope and Cape Horn, and whose imagination had been fired by the sight of the albatross, sporting in the tempest on rigid wings, and keeping up with the fleetest ships without exertion. He had killed one of these birds, and claimed to have observed a very remarkable phenomenon. In his own words, as quoted by M. de la Landelle:

> I took the wing of the albatross and exposed it to the breeze; and lo! in spite of me it drew forward into the wind; notwithstanding my resistance it tended to rise. Thus I had discovered the secret of the bird! I comprehended the whole mystery of flight.

Possessed with an ardent imagination, he early became smitten with the design of building an artificial bird capable of carrying him, whose wings should be controlled by means of levers and by a system of rigging; and when he returned to France, and had become the captain of a coasting vessel, sailing from Douarnenez (Finistère), where he was born, and where he had married, he designed and constructed with his own hands the artificial albatross shown in fig. 48.

* "Les Grandes Amours," G. de la Landelle, 1878, page 369.
† *Aéronaute*, March, 1879, page 86.
‡ "Dans les Airs," G. de la Landelle, 1884, page 210.

This consisted of a body in the shape of a "sabot," or wooden shoe, the front portion being decked over, provided with two flexible wings and a tail. The body was built like a canoe, being 13½ ft. long and 4 ft. wide at its broadest point, made of light ash ribs well stayed, and

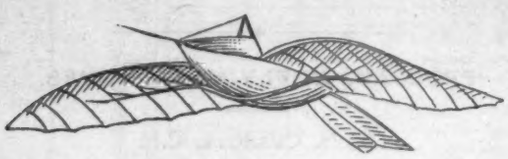


FIG. 48.—LE BRIS—1867.

covered on the outside with impermeable cloth, so it could float. A small inclined mast in front supported the pulleys and cords intended to work the wings. The latter were each 23 ft. long, so that the apparatus was 50 ft. across, and spread about 215 sq. ft. of supporting surface; the total weight, without the operator, being 92 lbs. The tail was hinged so as to steer both up and down and sideways, the whole apparatus being, as near as might be, proportioned like the albatross. The front edge of the wings was made of a flexible piece of wood, shaped like the front edge of the wing of the albatross, and to this, cross wands were fastened and covered with canton flannel, the flocculent side down. An ingenious arrangement, which *Le Bris* called his *rotules* (knee pans), worked by two powerful levers, imparted a rotary motion to the front edge of the wings, and also permitted of their adjustment to various angles of incidence with the wind. *Le Bris* was to stand upright in the canoe (an excellent position), his hands on the levers and cords, and his feet on a pedal to work the tail. His expectation was that, with a strong wind, he would rise into the air and reproduce all the evolutions of the soaring albatross, without any flapping whatever.

Le Bris's first experiment was conducted on a public road at Trefeuntec, near Douarnenez. Believing, like Count *D'Esterno*, that it was necessary that the apparatus should have an initial velocity of its own, in addition to that of the wind, he chose a Sunday morning, when there was a good 10-knot breeze from the right direction, and setting his artificial albatross horizontally on a cart, he started down the road against the brisk wind, the cart being driven by a peasant. The bird, with extended wings, 50 ft. across, was held down by a rope passing under the rails of the cart and terminating in a slip knot fastened to *Le Bris's* wrist, so that with one jerk he could loosen the attachment and allow the rope to run. He stood upright in the canoe, unincumbered in his movements, his hands being on the levers and depressing the front edge of the wings, so that the wind should press upon the top only and hold them down, their position being, moreover, temporarily maintained by assistants walking along on each side.

When they came to the right turn in the road the assistants were directed to let go, and the driver was told to put his horse on a trot. Then *Le Bris*, pressing on his levers, slowly raised the front edge of the wings to a very slight angle of incidence; they fluttered a moment, and then took the wind like a sail on the under side, relieving the weight upon the cart so much that the horse began to gallop. With one jerk *Le Bris* loosened the fastening rope, but lo! it did not run, and the bird did not rise. Instead of this, its ascending power counterbalanced the weight of the cart, and the horse galloped as if at full liberty. It was afterward ascertained that the running rope had been caught on a concealed nail, and that the apparatus had remained firmly fastened to the cart. Finally the rails of the latter gave way, the machine rose into the air, and *Le Bris* said he found himself perfectly balanced, going up steadily to a height of nearly 300 ft., and sailing about twice that distance over the road.

But an accident had taken place. At the last moment the running rope had whipped and wound around the body of the driver, had lifted him from his seat, and carried him up into the air. He involuntarily performed the part of the tail of a kite; his weight, by an extraordinary chance, just balancing the apparatus properly at the assumed angle of incidence, and with the strength of the brisk wind then blowing. Up above, in the machine, *Le Bris* felt himself well poised in the breeze, and exulted that he was about to pass two hours in the air; but below, the driver was hanging on to the rope and howling with fright and anguish.

As soon as *Le Bris* became aware of this state of affairs, and this was doubtless in a very short time, he took measures to descend. He changed the angle of incidence of his wings, came down slowly, and manœuvred so well that the driver gently reached the soil, entirely unharmed, and ran off to catch his horse, who had stopped when he again felt the weight of the cart behind him; but the equilibrium of the artificial albatross was no longer the same, because part of the weight had been relieved, and *Le Bris* did not succeed in reascending. He managed with his levers to retard the descent, and came down entirely unhurt, but one wing struck the ground in advance of the other and was somewhat damaged.

This exploit naturally caused a great deal of local talk. Captain *Le Bris* was considered a visionary crank by most persons, and as a hero by others. He was poor, and had to earn his daily bread, so that it was some little time before, with the aid of some friends, he repaired his machine and was ready to try it again.

He determined this time to gain his initial velocity by dropping from a height, and for this purpose erected a mast, with a swinging yard, on the brink of a quarry, excavated in a sort of pocket, the bottom of which was well protected from the wind. In this quarry bottom he put his apparatus together, and standing in the canoe, it was suspended to a rope and hoisted up aloft to a height of some 30 ft. above the ridge, and nearly 100 ft. above the quarry bottom. A fresh breeze was blowing inland, and the yard was swung so that the apparatus should face both the wind and the quarry, while *Le Bris* adjusted his levers so that only the top surfaces of the wings should receive the wind. When he had, by trial, reached a proper balance, he raised upward the front edge of the wings, brought the tail into action through the pedal, and thought he felt himself well seated on the air, and, as it were, "aspired forward into the breeze." At this moment he tripped the hook suspending the apparatus, and the latter glided and sailed off toward the quarry.

Scarcely had it reached the middle of the pocket, when it met a stratum of wind inclined at a different angle from that prevailing at the starting-point—a vertical eddy, so to speak—probably caused by the reaction of the wind against the sides of the quarry. The apparatus then tilted forward; *Le Bris* pressed on his levers to alter the plane of the wings, but he was not quick enough. The accounts of the bystanders were conflicting, but it was thought that the apparatus next oscillated upward, and then took a second downward dip, but in any event it finally pitched forward, and fell toward the bottom of the quarry.

As soon as the apparatus became sheltered from the wind it righted up, and fell nearly vertically; but as it exposed rather less than 1 sq. ft of surface to each pound of weight, it could scarcely act as a parachute, and it went down so violently that it was smashed all to pieces, and *Le Bris*, who at the last moment suspended himself to the mast of the canoe and sprang upward, nevertheless had a leg broken by the rebound of the levers.

This accident practically ruined him, and put an end for 12 or 13 years to any further attempt to prove the soundness of his theory. He had failed in both experiments for want of adequate equilibrium. He fairly provided for the transverse balance by making his wings flexible, but the longitudinal equilibrium was defective, as he could not adjust the fore-and-aft balance as instantly as the circumstances changed. The bird does this like a flash by instinct; the man was compelled to reason it out, and he could not act quickly enough.

M. de la Landelle makes the following comment:

He lacked the science of Dante (of Perugia), but he was ingenious, persevering, and the most intrepid of men. He was entirely in the right in locating himself upright, both arms and legs quite free, in an apparatus which was besides exceedingly well designed. None was better fitted than he to succeed in

sailing flight (*vol-à-voile*) in imitation of his model, the albatross.

In 1867 a public subscription at Brest enabled *Le Bris* to build a second artificial albatross, and this is the one represented by fig. 48. It was much like the first, but a trifle lighter, although a movable counterweight was added, intended to produce automatic equilibrium. The apparatus when completed was publicly exhibited, and attracted much attention; but the inventor no longer had the audacity of youth, and he was influenced by numberless contradictory counsellors. He wanted to proceed as at Douarnenez, by giving an initial velocity to his apparatus, but he was dissuaded from this. He was also urged to test his machine with ballast, instead of riding in it himself, which at once changed all the conditions of equilibrium, as there was no longer command over a varying angle of incidence, and yet a first mischance led him to resort to the method of experimenting without riding in the machine.

M. de la Landelle relates it as follows:

Once only did he obtain something like an ascension, by starting from a light wagon, which was not in motion. He was on the levee of the port of commerce at Brest, the breeze was light, and the gathered public was impatient, through failure to realize that success depended wholly on the intensity of the wind. *Le Bris* was hoping for a gust which should enable him to rise; he thought it had come, pulled on his levers, and thus threw his wings to the most favorable angle, but he only ascended a dozen yards, glided scarcely twice that distance, and after this brief demonstration came gently to the ground without any jerk.

This negative result occasioned a good many hostile comments, and so the inventor no longer experimented in public; but he had further bad luck; the machine was several times capsized at starting, and more or less injured, being repaired at the cost of *Le Bris*, whose means were nearly exhausted. Then he tried it in ballast with varying success, and on one occasion, the breeze being just right, it rose up some 50 yds., with a light line attached, and *advanced against the wind* as if gliding over it. Very soon the line became slack, and the assisting sailors were greatly astonished, for the bird, without waver, thus proceeded some 200 yds.; but at the approach of some rising ground, which undoubtedly altered the direction of the aerial current, the bird, shielded from the wind, began settling down, without jolt, very gently, and alighted so lightly that the grass was scarcely bruised.

Encouraged by this partial success, *Le Bris* tried to reproduce the same results, but he met many mishaps, in which the apparatus was upset and injured. At last, one day, by a stiff northeast breeze, he installed his bird on top of the rising ground near which it had performed so well a few weeks before, and this time he meant to ride in the machine himself. He was dissuaded by his friends, and probably made a serious mistake in yielding to them, for the uncontrolled apparatus was not intended to adjust itself to a gusty wind.

At any rate, the empty machine rose, but it did not sustain itself in the air. It gave a twist, a glide, and a plunge, and pitched forward to the ground, where it was shattered all to bits. The wings were broken, the covering cloth of the canoe was rent to pieces, while the bowsprit in front was broken and forced back like a dart into the canoe.

The friends claimed that if the operator had been aboard, he surely would have been spitted and killed, but *Le Bris* maintained that if he had been aboard he could, with his levers, have changed the angle of the wings in time to avoid the wreck; he blamed himself for having surrendered his better judgment, and he gave way to profound despair.

For this was the end. His second apparatus was smashed, his means and his credit were exhausted, his friends forsook him, and perhaps his own courage weakened, for he did not try again. He retired to his native place, where, after serving with honor in the war of 1870, he became a special constable, and was killed in 1872 by some ruffians whose enmity he had incurred.

Le Bris had made a very earnest, and, upon the whole, a fairly intelligent effort to compass sailing flight by imitating the birds. He finally failed for want of sufficient pecuniary backing, and also, perhaps, for lack of scientific methods and knowledge, for even at that day Captain *Béléguic*, a French naval officer, had called attention to the importance of securing longitudinal equilibrium, the lack of which caused the failure of poor *Le Bris*. Had he secured this he might have succeeded far better, especially if he had adhered to his original conception as to the necessity for that initial velocity against the wind, which served him so well upon the first trial and so ill upon the second. Singularly enough, he does not seem in all his subsequent experiments to have sought to give his apparatus that forward motion of its own, which he, like Count *D'Esterno*, originally held to be indispensable. He had also proposed to carry on his experiments at sea, from a steam vessel under way, and whatever may have been the cause that made him give up this idea, it was a misfortune, for his apparatus was capable of floating, he was himself an excellent swimmer, and had he experimented from a vessel under motion not only would he have been safe, but he would have had no lack of wind to rise upon the air.

He seems, if the accounts given be correct, to have exhibited some very remarkable phenomena of "aspiration," which we shall find reproduced in one or two experiments yet to be noticed, and which the soaring birds exhibit every day to the observer, but he was baffled by the lack of fore-and-aft equilibrium.

In 1867 Mr. *Smyth* patented, in Great Britain, a combination of aeroplanes with lifting and driving screws, which is shown in end view by fig. 49. It consisted of a

FIG. 49.—SMYTH—1867.

cylindrical car with pointed ends, to carry the passengers and the motor; of two aeroplanes, or light frames covered with silk, one at the front of the car and one at the rear, to furnish the supporting power when driven through the air by the propellers—one of which is shown in end view—and of two lifting screws, one above and the other below the car. These latter vanes were to be mounted at an adjustable angle upon vertical shafts passing through a tube in the car, the weight of the latter being transferred to them by means of a disc placed on rollers. This set of vanes was to be driven by one engine, and the horizontal propellers by another, so that the apparatus could be simultaneously lifted and driven forward if desired.

This arrangement is open to the objection that the resistance of the aeroplane has to be overcome in rising, and it is quite inferior to the proposal of *Crowell* patented in the United States in 1862, in which he had shown a pair of propellers (revolving in contrary directions), pivoted at the car, so that they might be brought overhead to ascend, and gradually dropped to the horizontal line to drive the apparatus forward, at which time a pair of aeroplanes, hinged at the car, and hanging vertically during the ascent, were also to be brought to a horizontal position to furnish a sustaining reaction.

Mr. *Smyth* seems to have apprehended that there might be some difficulty with his own arrangement, for he provides in his patent for a modification, in which he dispenses with the elevating propellers, and proposes to flap the sustaining surfaces or modified aeroplanes.

The principal feature of novelty, however, in Mr. *Smyth's* proposal was in the motor, which was to be a non-metallic apparatus, within which to explode gases to produce motion. This was to consist of a wooden cylinder, lined with a water-proof coating, and containing a series of india-rubber cells surrounded with water and connected with each other. Inside of these cells, which could be alternately collapsed or expanded, explosive mixtures of hydrogen and air were to be fired by electric sparks, the resulting expansion driving out a folding extension of the wooden cylinder, arranged like a concertina, and imparting motion to a jointed rod from which it was conveyed to the propellers.

The object was evidently to save the weight incumbent

upon metallic engines, the patentee asserting that india-rubber cells are not injured by exploding mixed gases in them, so long as they are kept moist. It is probable that experiments were made with some models of this novel motor, but no account of them seems to have been published. Mr. *Smyth* had described his proposed machine at the 1867 meeting of the Aeronautical Society of Great Britain, but had no model in the exhibition of that society in the ensuing year, where, however, an analogous idea was brought forward by Mr. *D. S. Brown*, through a model in which the ordinary cylinder and piston of a steam-engine were replaced by an india-rubber cloth bag, the alternate inflation and expansion of which produced the stroke. It was stated that the first steam-engine constructed by Hancock ran on the common road with an engine of this description, but that as the process of vulcanizing india-rubber was not then known, the steam speedily softened the texture and escaped through the canvas.

Fig. 50 shows the form of aeroplane patented in Great Britain in 1867 by *Butler* and *Edwards*, and was evidently due to some recollection of their school-boy days, when

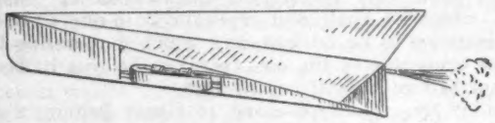


FIG. 50.—BUTLER & EDWARDS—1867.

they threw paper arrows in class. The stability of these little projectiles is quite good fore-and-aft, because the supporting surfaces increase in area while the intensity of the pressures diminish toward the rear, but the power required is great, and there is probably no aviating merit in this form. *Butler* and *Edwards* proposed to combine it in a variety of ways, superposing the sustaining planes, or placing two machines side by side, or both, and bracing between by diagonal ties. The form here shown is the simplest, the top planes being set at a slight diedral angle, in order to procure lateral stability.

The motive power was to be placed in a car, forward of the centre of figure, and capable of being moved forward and back, so as to shift the center of gravity to correspond with the center of pressure at varying angles of flight. The power was to consist in jets of steam issuing against the air in the rear; but, suspecting that this would be enormously wasteful, the patentees reserve the right of using screw propellers, driven either by the reaction of jets of steam issuing from curved arms (Hero's æolipile) or by an ordinary steam-engine, in which case the steam was to be exhausted and condensed back into water, in cells formed by doubling the surfaces of the planes and thus providing hollow spaces.

We now come to a celebrated experiment, which attracted great attention at the time; not so much because of the results obtained with the entire apparatus, for these were unsatisfactory, but because of the unprecedented lightness of the steam-engine in proportion to its estimated power.

Mr. *Stringfellow*, whose experiments in connection with *Henson's* machine have already been noticed, was much impressed with Mr. *Wenham's* proposal for superposing planes, and when the Aeronautical Society of Great Britain advertised an exhibition and offered prizes, he constructed and entered two models for competition in 1868.

One of these models was the apparatus shown in fig. 51, and consisted of three superposed planes and of a tail, driven by a screw propeller moved by a steam-engine. The aggregate frontage was 21 lineal feet and the sustaining area of the three planes was 28 sq. ft., while the tail added some 8 ft. more, thus making some 36 sq. ft. The weight, including the aeroplane, engine, boiler, fuel and water, was under 12 lbs., thus giving a proportion of about 3 sq. ft. per pound, which was certainly ample for support. The engine was rated at one-third of a horse-power, but its weight is not stated.

The machine ran suspended along a wire, in the central transept of the Crystal Palace in London. It was forced by its propellers at great speed, but generally failed to lift itself from the wire, although Mr. *Stringfellow* said that it occasionally did so, and was then sustained by its

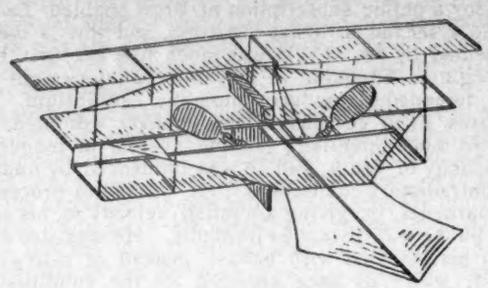


FIG. 51.—STRINGFELLOW—1868.

superposed planes alone. This failure to rise may have been due to the fact, stated by M. Hureau de Villeneuve, that the axis of the screw was parallel with the sustaining planes, so that there was no angle of incidence, but a better explanation lies in the fact that the equilibrium was so imperfect that it was not safe, for fear of breakage, to liberate the machine. This, however, was done in the basement of the Crystal Palace, after the close of the public exhibition, a canvas being held to break the fall, and M. Brearey, an eye-witness, says:

> When freed, it descended an incline with apparent lightness until caught in the canvas; but the impression conveyed was that had there been sufficient fall, it would have recovered itself. . . . It was intended at the last to set this model free in the open country, when the requirements of the Exhibition were satisfied, but it was found that the engine, which had done much work, required repairs. Many months afterward, in the presence of the author (M. Brearey), an experiment was tried in a field at Chard, by means of a wire stretched across it. The engine was fed with methylated spirits, and during some portion of its run under the wire, the draft occasioned thereby invariably extinguished the flames, and so these interesting trials were rendered abortive.

This apparatus (restored) is now in the National Museum of the Smithsonian Institution at Washington, where it is said that the engine cannot now develop anything like the power originally claimed.

The remark has well been made that so far as concerns the motive power, this apparatus ought to have flown. Its weight was only that of a goose, and it was said to have one-third of a horse-power. This may have been overestimated, but then Mr. *Maxim* estimates the power of a goose at 0.083 of a horse-power, and so there is ample margin.

There were two reasons for the failure. In the first place the sustaining surfaces were at least three times those of the goose, and hence the "drift," or horizontal component of the air pressure, would be much greater in the aggregate, so that the discrepancy in power is not as great as at first sight appears; and in the second place, and more important, the equilibrium was so defective that the inventor did not dare liberate his model, while freedom of action is the first condition of successful experiment in flight. He had done better with single planes on the previous occasion which has been mentioned, but the failure with superposed planes in 1868 does not necessarily condemn them. It merely indicates that the surfaces must be of correct shape and skilfully arranged, and, if possible, produce automatic stability. If the equilibrium be unstable, like that of the bird, it is well enough to have more power than the goose, but it is much more important to possess its skill.

The second model of Mr. *Stringfellow* consisted in a steam-engine, similar to that applied to the complete apparatus, but larger. It was entered in the catalogue thus:

> Light engine and machinery for aerial purposes, about half horse-power, cylinder 2 in. diameter, 3 in. stroke, generating surface of boiler, 3½ ft.; starts at 100 lbs. pressure in three minutes, works two propellers of 3 ft. diameter, about 300 revolutions per minute. With 3½ pints of water and 10 oz. of liquid fuel, works about ten minutes. Weight of engine, boiler, water, and fuel, 16½ lbs.

Subsequently the examining jury estimated the power at one full horse-power, the weight of the engine and boiler alone being 13 lbs., and it awarded a prize of $500 to Mr. *Stringfellow* for "the lightest engine in proportion to its power, from whatever source that power may be derived."

With this prize money Mr. *Stringfellow* erected a building over 70 ft. long, in which to experiment with a view of ultimately constructing a large machine to carry a person to guide and conduct it, his experience with models having evidently impressed him with the necessity for intelligent control of any aerial apparatus not possessing automatic stability; but he was already 69 years of age, his sight became impaired, and he died in 1883, without having accomplished any advance on his previous achievements.

A reference is made by M. de la Landelle in "Dans les airs" to an "Essay upon the Theory of Flight," published in 1869 at Copenhagen by Professor *Krarup-Hansen*, giving an account of an apparatus carrying a man who, by means of pedals, put into action horizontal wings whose action imparted motion to the machine, but the account is too scanty to determine whether this refers to beating wings or to an aeroplane.

Almost the same may be said concerning a large artificial bird, whose wings covered with feathers were more than 32 ft. across, constructed in 1845 by M. *Duchesnay* and exhibited in Paris, but which does not seem to have been tried in the open air. Somewhat more definite is the account given of some experiments by M. *Marc Seguin*, the celebrated French civil engineer, who in 1846 tried two series of experiments, one with lifting screws, and the other with an apparatus weighing 150 lbs., with a pair of canvas wings measuring 65 sq. ft. in area, from which he drew rather discouraging conclusions. He, however, tried another series of experiments in 1849, with an apparatus weighing 35 lbs. and worked by a man, the total weight, including ballast and operator being 232 lbs. This actually left the ground, and raised up some 6 to 8 in., but the effort required was evidently so violent as not to warrant further experimenting with man-power.

(TO BE CONTINUED.)

THE TRANSITION CURVE.

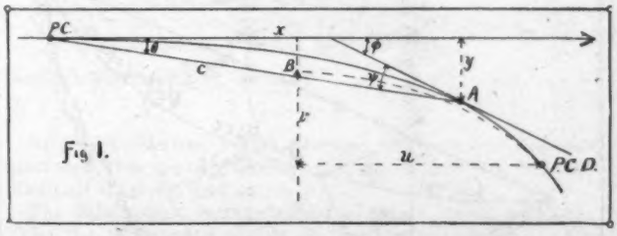
By W. H. Echols.

1. A car of weight W and velocity V miles per hour, in passing from the tangent to a circular curve of radius, R, has its direction suddenly changed by the impulse

$$\frac{1}{15}\frac{W V^2}{R},$$

causing, as the car enters the curve, a corresponding shock, which is not experienced while the car is on the curve, but is repeated as it leaves the curve for the terminal tangent.

In order to avoid this shock the deviating force must be applied gradually; and since it is not practicable to lower



the velocity, we regulate the deviating force by changing the radius. Thus, if we make the radius change uniformly (per length of curve) from ∞ to R, then the deviating force changes gradually from zero up to its full value as the car enters the circular curve.

2. If the track remain level transversely on curves, the deviating force is caused by the grinding or bearing of the wheel flange against the outer rail. In order to remove the tendency of the flange to climb the rail and the train therefore to leave the track, the road-bed must be given an inclination transversely such that the resultant of the reaction of the deviating force and the vertical weight of the car is perpendicular to the road-bed. The car will then have no tendency to leave the track.

In order to determine this inclination, say θ, let F be the horizontal reaction of the deviating force, and let W be the weight of the car. Then, in order that there may be no tendency to slide up the plane due to centrifugal force, or to slide down the plane due to gravity, we must have the components of these two forces parallel to the inclined plane equal. Hence

$$F \cos.\ \theta = W \sin.\ \theta,$$

or,

$$\tan.\ \theta = F/W.$$

Since F is small compared with W, the angle θ is also small, and therefore nearly enough equal to its tangent, sine, or circular measure.

$$\therefore \tan.\ \theta = H/G = F/W.$$

Where H is the super-elevation of the outer rail, and G is the gauge of the track,

$$\therefore H = \tfrac{1}{8}\frac{V^2}{R} = 0.000055\ V^2 D,$$

D being the degree of curve at any point.

With the increasing tendency to fast time, the super-elevation should be designed with reference to a velocity of 30 miles per hour, which gives for H at any point of a curve where the degree is D, $\frac{1}{2}$ tenth per degree of curve, or,

$$H = \tfrac{1}{20} D.$$

The super-elevation should begin with zero at the $P\,C$ and increase uniformly up to its full value at the beginning of the circular curve D.

If S be the length of the transition in feet, then we have for the grade of the outer rail relative to that of the inner rail

$$g = H/S.$$

It is the maximum admissible value of g that regulates the length of the transition curve. Let us suppose that g is this maximum value.

3. Design of the transition.

Let D be the degree of the main curve, beginning at $P\,C\,D$, radius R.

Let s be the distance in feet and l in chains of a point A, on the curve from $P\,C$ measured along the curve.

Let θ_0 be the angle in degrees between the long chord c and the initial tangent.

Let ϕ_0 be the angle which the tangent at A makes with the initial tangent.

Let ψ_0 be the angle between the chord c and the tangent at A.

Let δ and ρ be the degree and the radius of the transition at A, and let R_1 be the radius of a one degree curve.

Let the capital letters Θ, Φ, Ψ, S, L, etc., have like meaning for the terminal point $P\,C\,D$ of the transition.

Let y be the offset in feet from the initial tangent to A, at a distance x feet from $P\,C$ along the tangent.

Let B be the point of contact of a tangent parallel to the initial tangent touching the main curve produced backward.

Let p be the offset of B from the initial tangent at a distance q from $P\,C$ along the tangent.

The fundamental property of the transition is

$$\delta = \frac{R_1}{\rho} = ms,$$

where m is a constant which must be determined to suit the practical conditions of the problem, dependent on g, since § 2,

$$m = 20\,g.$$

We have,

$$d\phi = \frac{ds}{\rho} = \frac{ms\ ds}{R_1}.$$

$$\therefore \phi = \frac{ms^2}{2R_1}.$$

Or in degrees

$$\phi_0 = \frac{ms^2}{200} = \frac{100}{2} ms^2.$$

Also

$$dy = ds\ sin.\ \phi = \phi\ ds,$$

$$= \frac{ms^2}{2R_1} ds.$$

$$\therefore y = \frac{ms^3}{6R_1},$$

the error being only,

$$+ \frac{m^3 s^7}{42 R_1^3}.$$

And,

$$dx = ds\ cos.\ \phi = ds\ (1 - \tfrac{1}{2}\phi^2).$$

$$\therefore x = s,$$

the error being only,

$$+ \frac{m^2 s^5}{10 R_1^2}.$$

Also,

$$tan.\ \theta = \theta = \frac{y}{x} = \frac{ms^2}{6R_1} = \tfrac{1}{3}\phi.$$

And,

$$\psi_0 = \phi_0 - \theta_0 = 2\theta_0.$$

The tangent distance for locating $P\,C$ is

$$T = (R + p)\ tan.\ \tfrac{1}{2} I + \tfrac{1}{2} S,$$

I being the angle between initial and terminal tangents.

For, see Fig. 1,

$$u = R\,\Phi = \frac{R_1}{ms} \frac{ms^2}{2R_1} = \tfrac{1}{2} S = q.$$

And

$$v = u^2/2R.$$

Therefore,*

$$p = \tfrac{1}{4} V.$$

The external of the curve with the transition is longer than that of the simple curve without the transition by an amount,

$$p\ sec.\ \tfrac{1}{2} I.$$

The length of the main curve of D degree, is in chains,

$$ID - L.$$

The length of the whole curve from $P\,C$ to $P\,T$ being

$$ID + L.$$

4. Applications.

We distinguish between first-class roads in good country whose maximum curvature is about 8°, and whose maximum grade does not exceed 1'.5 per station, and those roads in bad country whose maximum curvature may be 16° or over, and maximum grade 3 per cent.

In the first case, the value g, the maximum admissible grade of the outer rail over that of the inner rail should not exceed 0.2 per station. And in case of the latter, g should not exceed 0.3.

5. The following is the design for roads of maximum curvature, of say 8° :

$g = \frac{2}{10}\%$, then $m = \frac{8}{1000}$.

Therefore

$$S = \tfrac{100}{8} D, \qquad L = \tfrac{1}{8} D,$$
$$x = s, \qquad \theta_0 = \tfrac{1}{2} l^2,$$
$$y = \tfrac{2}{3} l^2, \qquad \psi_0 = 2\theta_0,$$
$$T = [R + (\tfrac{2}{10} D)^2]\ tan.\ \tfrac{1}{2} I + \tfrac{1}{2} S.$$

To run in a D degree curve, measure off T and locate $P\,C$, set up there and run the transition curve in with the deflections $\theta_0 = \frac{1}{2} l^2$. To recover the tangent at any point, deflect from the chord the angle $2\theta_0$. Of course the curve may be put in with the offset $y = \frac{2}{3} l^2$, and $x = s$, if preferred.

To run the transition in backward—that is, from $P\,C\,D$ to $P\,C$—as is required at the end of the main curve. Deflect from the tangent at $P\,C\,D$ the angle

$$\theta_0' = L^2 - \tfrac{1}{2}(L - l)(2L - l),$$

in order to set a point at a distance, l, chains from $P\,C\,D$. Easily proved by considering the triangle with vertices at $P\,C$, A, and $P\,C\,D$, remembering that the angles are small and therefore proportional to their sines.

6. If the maximum curvature be 16°, we may put

$$g = \tfrac{3}{10}\%, \qquad \therefore m = \tfrac{6}{1000}.$$

The formulæ for doing the work are as before,

$$\theta_0 = l^2, \qquad x = s, \qquad L = \tfrac{1}{8} D,$$
$$\psi_0 = 2 l^2, \qquad y = \tfrac{2}{3} l^2,$$
$$T = [R + 2(\tfrac{1}{10} D)^2]\ tan.\ \tfrac{1}{2} I + \tfrac{1}{2} S.$$
$$\theta_0' = 2L^2 - (L - l)(2L - l).$$

7. It does not seem possible to get simpler formulas. In no case, for the maximum curves, will these formulas give an error of as much as one-half of one-tenth of a foot, or one-half of one minute of angle.

[1] This is the transition curve suggested by me in the publication of the Missouri School of Mines, June, 1890, and developed by Professor H. H. Talbot in the University of Illinois, *Technograph*, 1891.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

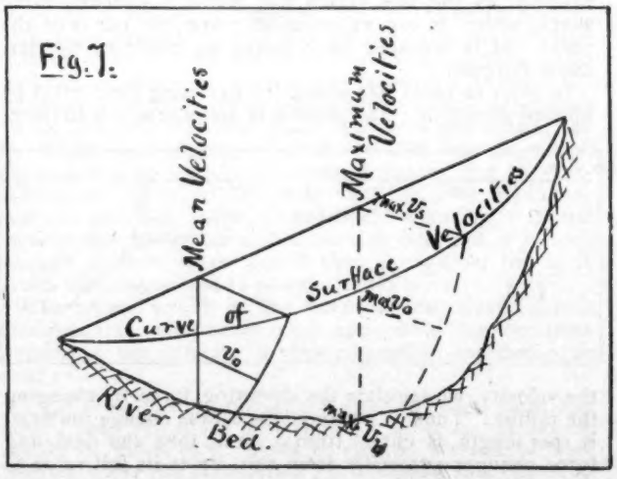
(Copyright, 1892, by M. N. Forney.)

(*Continued from page* 404.)

WATER-LEVELS.

Besides the observations of water-level, made during the time of survey and location, it is necessary to collect the observations made at the neighboring water-gauge stations (if any have been established), and to get from the country people information as to the height of the highest floods and the levels of the ice running in spring and autumn. Sometimes it is possible to find on the shore the marks or traces of the highest level and of the ice running.

Fig. 1.



The information concerning the limits of spring and autumn ice running, and of the thickness and force of the

ice and the character of its running--as in large cakes or broken up—are especially important, being necessary for the proper design of the ice-breakers of the piers.

For the result there should be given the heights of the following levels :

1. The lowest (in summer or autumn).
2. The highest (in spring).
3. The lowest level of the autumn ice.
4. The highest level of the spring ice breaking up and running out.

It is also necessary to get information concerning the usual time of freezing and of breaking up of the ice, and the duration of the spring and autumn ice running.

NAVIGATION AND VESSELS.

As the designed bridge should not hinder the existing navigation, information concerning the character of it, and especially information on the dimensions of vessels, their draft and height of superstructure—cabins, chimneys, etc.—should be collected with great accuracy.

RECAPITULATION OF DATA.

The investigation of a river crossing is complete when the following data have been obtained :

1. The value of the maximum discharge of river near the site of the proposed bridge, and the value of the corresponding mean velocity (being equal to the maximum velocity on the bottom).
2. The topographic plan of the portion of the river near the site of the bridge, with the lines of equal depth, the horizontals of shores, and the directions of currents.
3. The transverse profile of the river along the line of the bridge, with evidence of the kind of ground to the necessary depth—that is, to solid ground, or even to 75 or 100 ft. below the low-water level.
4. Information about the different water-levels—viz., low, high, and that of the spring and autumn ice, and information about the dimensions of the ice.
5. Information about the navigation and the dimensions of vessels.

GENERAL DESIGN OF THE BRIDGE.

All the above enumerated data are quite sufficient for the general design of the bridge ; for, having them, it is possible to determine the chief elements of the design, or to state the chief conditions of the design for the bridge —viz. :

1. The minimum clear opening.
2. The depth of foundations of abutments and piers.
3. The elevation of the superstructure above the water-level.
4. The most economical and convenient distribution of spans and piers.

DETERMINATION OF CLEAR OPENING.

From the given maximum discharge of the river, the total clear opening of the bridge can be determined in two suppositions : 1. That washing out or scouring of the bed is *not* allowed ; and, 2. Allowing this washing out of the river-bed to any fixed depth.

I. *The washing out of bed not considered.*—If we call, for the highest water-level,

Q = the maximum discharge,
w = the corresponding area of cross-section, and
v = the mean velocity of the water,

then, as above stated, we have

$$Q = w\,v.$$

After the construction of a bridge, the area of cross-section and the mean velocity may be different ; and we may call them w_0 and v_0.

The value of w_0 is determined in the following manner : Take the transverse profile of the river at the site of the bridge, and draw on it the elevation of the bridge as designed ; then from the area of the cross-section w—the area delineated by the line of highest water-level and the wetted perimeter of the bed—subtract the area of the immersed portions of piers, abutments and rip-raps. The difference will approximately give the value of w_0.

The quantities w_0 and v_0 should satisfy the equation

$$Q = \mu\, w_0\, v_0,$$

where μ is the co-efficient of contraction, depending upon the form of piers in the plan :

For quadrangular form, $\mu = 0.85$
" semicircular " $\mu = 0.90$
" acute angle " $\mu = 0.95$

From the equation $Q = \mu\, w_0\, v_0$ we deduce

$$v_0 = \frac{Q}{\mu\, w_0},$$

and as $\mu < 1$ and $w_0 < w$, therefore we always have $v_0 > v$. This increase of the mean velocity is accompanied by an increase of the surface velocity and the bottom velocity. The former of them, when too great, may hinder the navigation ; the latter, when beyond a certain limit, may wash out the subsoil and injure the foundations.

As the mean velocity of the given cross-section is equal to the average velocity of a certain vertical, therefore with a sufficient approximation it can be assumed that the surface velocity and bottom velocity in that vertical will be equal to the mean surface velocity and the mean bottom velocity of the whole cross-section (see fig. 7). Consequently these quantities are given by the series of preliminary observations.

In order to get the maximum surface velocity v_s and the maximum bottom velocity v_b we take from observations the maximum average velocity in a vertical (the average velocity in the vertical of maximum velocities), and from that maximum average velocity, which we call v_{max}, we calculate the required velocities v_s and v_b by means of the well-known formulas of Weissbach, Lohmeyer and Eytelwein.

According to Weissbach's formula, the maximum surface velocity,

$$_{max}v_s = \frac{v_0}{(0.915)^2} = \frac{v_0}{0.83},$$

and the maximum bottom velocity

$$_{max}v_b = 0\,83\ {}_{max}v_s = v_0.$$

According to Lohmeyer's formula (in meters),

$$_{max}v_b = (0.8617 - 0.469\,k)\ {}_{max}v_0,$$

where k is the value of the rise of water caused by the bridge.

According to Eytelwein's formula (in feet),

$$_{max}v_b = {}_{max}v_0\,(1 - 0.0075\,k).$$

The value of the maximum bottom velocity $_{max}v_b$ may be calculated by means of all these three formulas, and taken at the average of the results.

This calculation is satisfactorily exact when the value of the rise of water (k) is insignificant, which is generally the case, the value of k in ordinary conditions being not more than a few inches. On the contrary, when the value of k is of some importance, the bottom velocity should be increased by the quantity depending upon the head of the layer of water of thickness $= k$, and this increment of velocity will be expressed by the formula

$$v_b' = \sqrt{2\,g\,k + v_b^2}.$$

Having thus calculated the maximum bottom velocity, it is necessary to compare it with the velocity at which the washing out or scouring of the bottom soil begins.

The velocities at which the washing out of different kinds of ground begins are shown in the following old and well-known table :

Description of ground.	Velocity in feet.
Loam	½
Clay	1
Clay with sand	2
Gravel	4
Coarse gravel (hard pan)	5
Pudding, or conglomerates	7
Stratified rocks	9
Solid rocks	14

The figures given in this table should be considered as too small, for the observations of velocities in existing bridges have shown that a bottom velocity of 5 to 6 ft. does *not* wash sandy beds, especially when such velocities do not last a long time.

Instead of using the above table, the maximum value of the bottom velocity, which can be allowed in every special case, can be determined by the following method: Take, from the observations, the maximum bottom velocity in the uncontracted main channel, and at its deepest point; it is obvious that this velocity does *not* wash out or scour the bed, and, therefore, it can be taken as the maximum bottom velocity to be allowed in the contracted channel; the more so that here the distribution of velocities along the cross-section is more regular than in the uncontracted channel.

If the value of maximum bottom velocity ($_{max}v_b$), calculated by the formulas given above, is found greater than the maximum bottom velocity allowed from table or observation, then it is necessary either to increase the area of the contracted cross-section, or in some way to protect the bottom. The increase of the area of cross-section can be made either by enlarging the clear opening, or, when the required increase is small, by cutting out the bottom and giving it a regular form.

Having so arranged that the bottom velocity will not wash out the bottom, it remains to prove whether the surface velocity will not hinder the navigation. This velocity should not exceed certain limits, depending upon the nature and character of navigation. According to Debauve, the upward navigation is difficult when the surface velocity is 3½ ft. per second, and the downward navigation when the surface velocity is 5½ ft. per second.

It remains to calculate the value of the rise of water occasioned by the bridge. For that purpose, we take three cross-sections of the river—above the bridge, on it, and below it—and we call by

w' the area of cross-section above the bridge,
w_o " " " under the bridge,
w " " " below the bridge,

and by v', v_o and v the corresponding mean velocities.

Assuming that the form of cross-section in these three profiles is the same, and calling the width of the river L, and the rise of water k, we have

$$w' = w_o + L\,k.$$

And as

$$k = \frac{v_o^2 - v^2}{2\,g}$$

and

$$(w + L\,k)\,v' = \mu\,w_o\,v_o = w\,v,$$

therefore

$$v_o = \frac{w\,v}{\mu\,w_o}, \quad v' = \frac{w\,v}{w_o + L\,k},$$

and finally

$$k = \frac{w^2\,v^2}{2\,g}\left(\frac{1}{\mu^2\,w_o^2} - \frac{1}{(w + L\,k)^2}\right).$$

We see that the value of k enters into the second member of this equation, and therefore it should be calculated by consecutive approximations, beginning from $k = 1$ or 2 in.

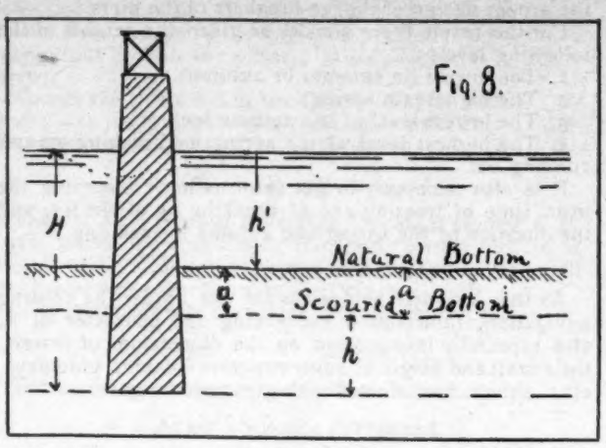
II.—*The washing out or scouring of bed being considered.*—Suppose that the washing out of bed or scouring is allowed to a certain depth defined by the following conditions:

1. Thickness of earth layer above the base of foundation, which is necessary for the stability of abutment or pier.
2. Depth of the river.
3. Greatest possible depth of sinking the foundation with given means and in the given circumstances.

If we call these quantities h, h' and H, then, in fig. 8, the depth of the layer which can be allowed to be washed out is given by the formula

$$a = H - (h + h').$$

Having so determined the greatest allowed depth of washing out, a, we shall assume some value of clear opening, say l, and verify its sufficiency by computing the washing out corresponding to that clear opening, l.



We can here distinguish two cases: 1. When the width of flood is not great and the velocities are not very different; and, 2. When the width of flood is very great (10 or more times more than the normal width of river) and the velocities in them are very different. In the first case, the discharge is given by the formula

$$Q = w\,v = L\,r\,v,$$

where L is the width of the river before the construction of bridge, r the mean depth, and v the mean velocity of water. After the contraction of cross-section of channel by the bridge, we get

$$Q = \mu\,w_o\,v_o = \mu\,l\,r\,v_o,$$

where l is the assumed value of clear opening or waterway, r = the same mean depth, and v_o the mean velocity of the contracted channel, and μ the co-efficient of contraction (0.85 — 0.90 — 0.95).

As $\mu < 1$, $l < L$; therefore $v_o > v$. Supposing that the ground of the bed does not resist this increased velocity and will be washed out, the depth and the mean depth will increase, and consequently the mean velocity v_o will diminish till the corresponding bottom velocity becomes equal to its previous value, and then

$$Q = w\,v = \mu\,l\,r'\,v,$$

where r' is the mean depth after the washing out has finished.

As $\mu < 1$, therefore $l\,r' > L\,r$; and if before the washing out the values of the mean and greatest depths were r and $r_m = a\,r$, then, assuming the same ratio after the washing out, we will have

$$r'_m = a\,r',$$

and the greatest washing out corresponding to the assumed clear span l will be

$$r'_m - r_m = d_m.$$

If this quantity (d_m) is less than the above-defined limit of permissible washing out a, then the assumed clear opening l is available; in the contrary case, the value of the clear opening l should be increased till it satisfies the condition $d_m < a$.

In the second case, when the width of flood is very great, and even when the river consists of two or more separated channels, with different velocities, then it is quite correct to suppose that the washing out of the bed will stop when the mean bottom velocity of the whole contracted cross-section becomes equal to the corresponding velocity of the main channel.

Dividing the cross-section of the flood into three channels—left, mean, and right—marked by indices 1, 2, and 3, as in fig. 9, we have

$$Q = w_1\,v_1 + w_2\,v_2 + w_3\,v_3.$$

After the construction of the bridge, and the washing out of the bed caused by it, the mean velocity will be v_2, and we will have

$$Q = \mu w' v_2 \quad \therefore \text{ the area of cross-section } w' = \frac{Q}{\mu v_2}.$$

If, as above, we design the clear span of the bridge by l, the mean velocity after the washing out by r', then

$$w' = l r',$$

and

$$r' = \frac{w'}{l}.$$

If r and r_m are the mean and maximum depths before the

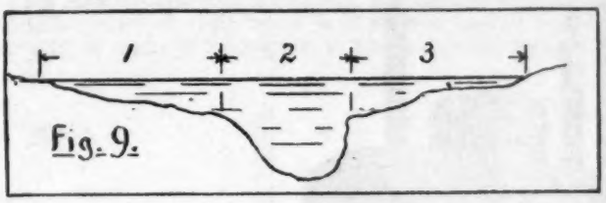


Fig. 9.

washing out, and $r_m = a r$, then it is very probable that after the washing out the greatest depth r' will be

$$r'_m = a r'$$

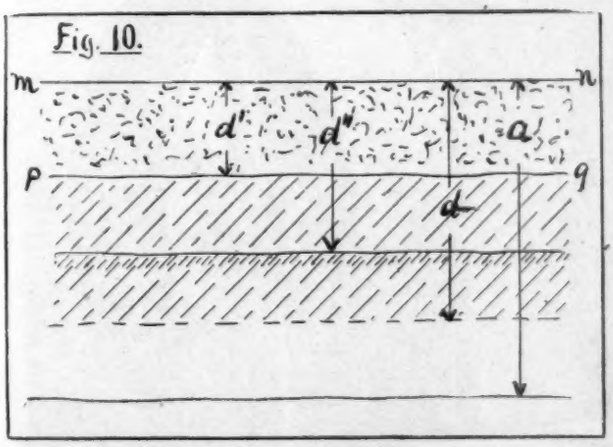
and the value of the washing out

$$r'_m - r_m = d.$$

The availability of l is defined by the condition that d be less than a.

If weak or soft ground extends to a depth greater than a—a limit conventionally fixed by the stability of the foundation—then the washing out will last till that moment when the velocity becomes equal to the original velocity; but when at a certain depth less than d and less than a there is stronger ground, then the washing out will not reach the depth d; the velocity under the bridge will be greater than that below it, and a rise of water will occur.

Fig. 10.



The value of this rise k can be so computed from the real washing out, d', fig. 10.

Let $m\ n$ be the river bottom, $p\ q$ the limit of soft ground, d the limit of washing out, in the supposition of uniform soft or easily scoured ground. In the beginning the ground will be washed out to the depth d'; if at that moment the bottom velocity be greater than the limiting velocity of the lower layer, that layer will be washed out to a certain depth, d'', when the bottom velocity becomes equal to that limiting scouring for that stronger ground. This quantity can be computed by consecutive approximations.

If to the depth d'' correspond the cross-section w'' and the mean velocity v'', then the rise of water is given by the formula

$$k = \frac{1}{2g}(v''^2 - v^2)$$

where

$$2g = 64.4 \text{ ft.}$$

(TO BE CONTINUED.)

THE UNITED STATES NAVY.

THE first Whitehead auto-mobile torpedo ever fired from the gun of an American war vessel in this country was shot from one of the three 18-in. torpedo-tubes of the torpedo-boat *Cushing*, at Peconic Bay, September 1. Two others were equally successful, and the guns worked to the satisfaction of the Torpedo Board. The torpedoes were 11 ft. 8 in. long and 18 in. in diameter. They were made of steel ⅛ in. thick at the forward end, and with a compressed air chamber having a capacity of 7 cub. ft. of air at a pressure of 1,350 lbs. to the square inch. It being desired to test the guns and not the torpedoes, the latter carried no gun-cotton and their propellers were not used.

THE next ship to be launched for the Navy is the *Cincinnati* at the New York Navy Yard, which is nearly ready. She is one of the 3,000-ton cruisers, and is a sister ship to the *Raleigh*, built at the Norfolk Yard, which was described and illustrated in the JOURNAL for May last.

THE plans for the new armored cruiser and battle-ship are not yet quite complete in the Navy Department, but it is expected that they will be ready about November 1, so that bids can be received by the close of the year. The general plan of both has been decided on.

The battle-ship will be for the present designated as No. 4; she will have about 1,000 tons more displacement than the three now under construction. The general dimensions will be: Length, 360 ft.; beam, 72 ft.; draft, 24 ft.; displacement, 11,250 tons; engines, 11,000 H.P.; speed, 16½ knots. The armament is not fully decided on, but will probably include four 12-in. guns, several 8-in. guns and a number of 4-in. or 5-in. rapid-fire guns.

The armored cruiser, which is to be named *Brooklyn*, will be the same type of ship as the *New York*, but somewhat longer and of 1,000 tons greater displacement. Her general dimensions will be: Length, 400 ft.; beam, 64 ft.; draft, 23 ft.; displacement, 9,150 tons; engines, 16,000 H.P.; speed, 20 knots. The armament will probably include eight 8-in. guns, twelve 5-in. rapid-fire guns, a number of smaller rapid-fire and machine guns and five torpedo-tubes. She will, like the *New York*, have four engines, two for each screw, and will have a capacity for a large coal supply.

NOTES.

IT is worthy of note that the Greenland expedition of Civil Engineer Robert E. Peary, U. S. N., has returned in safety, after reaching the point furthest north to which a civilized man has ever penetrated, latitude 81° 37'. Many facts in relation to the geography of Greenland and the northern ice-belt were ascertained. Mr. Peary's original programme was fully carried out, and the only casualty was the loss of one man, whose death seems to have been due chiefly to his own recklessness.

ON September 1 there were, according to the *American Manufacturer's* tables, 240 furnaces in blast, having a capacity of 156,584 tons of pig iron weekly. This is a reduction during August of two furnaces in number, and of 1,997 tons in the weekly output. As compared with September, 1891, the capacity of the furnaces in blast shows a decrease of 18,312 tons, or about 10½ per cent. A further decrease in production hardly seems probable, as a material reduction in stocks of pig iron on hand is reported.

THE Ordnance Department of the Army has recently awarded contracts to the Bethlehem Iron Company for 12 sets of forgings for 10-in. guns; nine sets for 12-in. guns and seven for 12-in. steel mortars. The Midvale Steel

Company received contracts for ten sets of forgings for 8-in. guns; ten for 7-in. siege howitzers; ten for 5-in. siege-train guns and 25 sets for 3.2-in. field guns. The contract for steel armor-piercing projectiles has not been awarded.

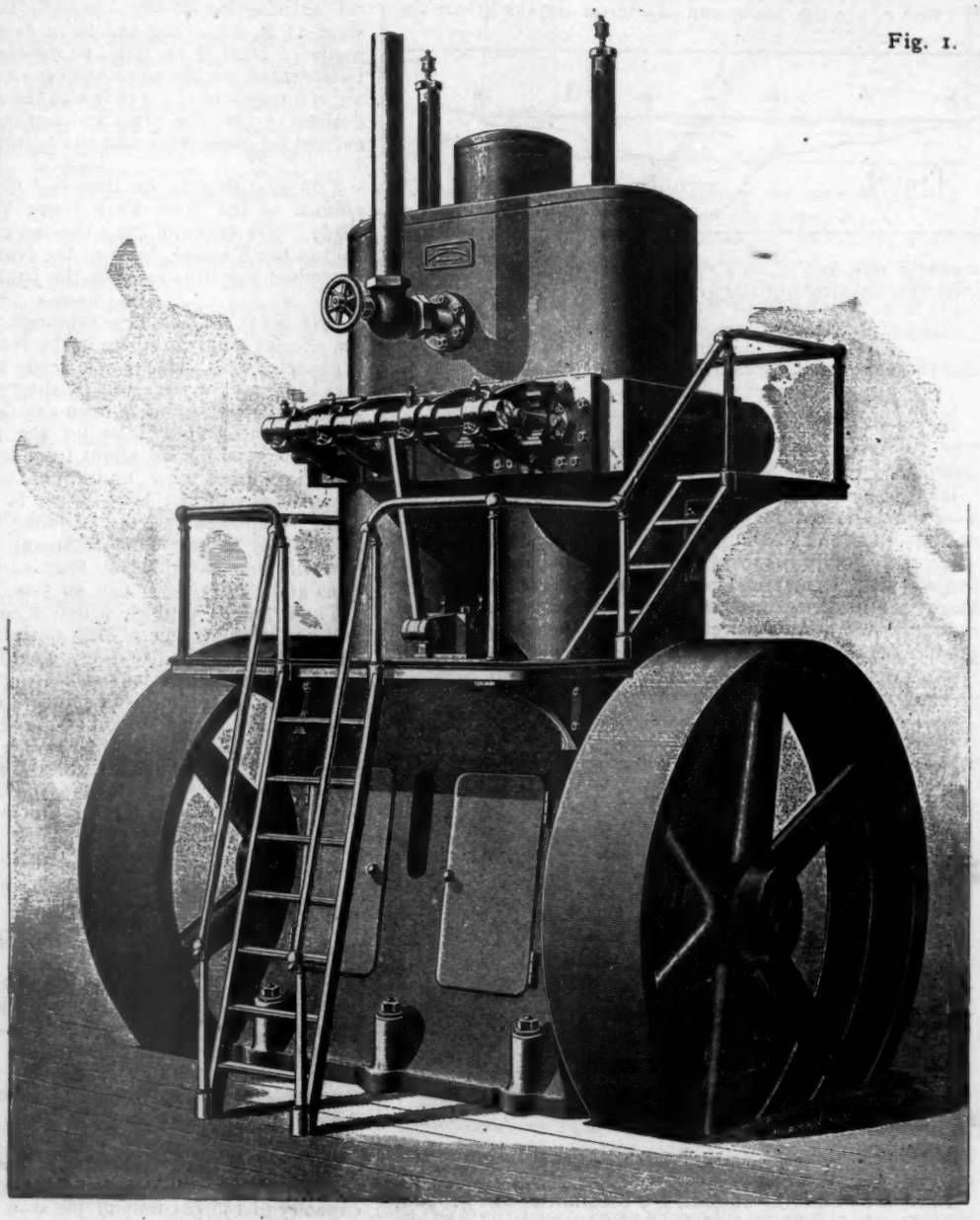
STRONG'S VERTICAL TRIPLE-EXPANSION ENGINE.

THE engine shown in the accompanying illustrations has been designed to meet the demand for a compact machine suitable for electric dynamo driving, and for other purposes where it is desirable to economize space, to secure economy in fuel, and to utilize the higher ranges of expansion, either as a condensing or non-condensing engine. There are many places where it is not practicable to use a condenser on account of the scarcity of condensing water, and as it is possible to secure about the same economy with very high steam pressure without condensation, this engine has been designed to fulfil that end. An effort has been made to put a triple-expansion engine into the simplest and most compact form, and at the same time to meet all the requirements that are considered necessary for general efficiency and economy. Fig. 1 is a perspective view of an engine of this class; figs. 2 and 3 are front and side views, showing the construction.

A peculiarity of the design is that the engine is self-contained and balanced. The reciprocating parts of the two sides have simultaneous opposite movements, the cranks being 180° apart, and thus in a manner balancing each other. In consequence of this, and of the fact that each side is independently balanced by a counterweight on the crank, less foundation is required, and more quiet running produced than would otherwise be the case. This is very important in buildings where jars from engines are very annoying. If it is desired that the engine shall be absolutely noiseless, it can be placed upon a foundation insulated on the bottom by cork from the foundations of the building, while on the sides packing or other material can be used that will transmit neither noise nor vibrations to the walls.

To meet the requirements of an engine using steam of 180 to 200 lbs. pressure, piston-valves have been selected for the high-pressure and intermediate cylinders, and gridiron slide valves for the low-pressure cylinders. By this means frictionless valves for the high and intermediate cylinders, where the pressure is high, are secured. In those cylinders the matter of clearance is comparatively unimportant. In the low-pressure cylinders, however, small clearances are very necessary for economy, and are brought about by the use of the gridiron valves in the cylinder-heads. As will be seen from the engravings, the high-pressure cylinder is placed over one of the low-pressure cylinders, and the intermediate cylinder over the other. The low-pressure cylinders take steam only on one side of the piston.

Fig. 1.



STRONG'S TRIPLE-EXPANSION ENGINE.

The piston-valve of the high-pressure cylinder is actuated by a block sliding in the well-known Fink link, so designed as to give a perfectly equal lap and lead, and at the same time equal cut-offs at both ends of the cylinder. The position of this block, and therefore the cut-off, is controlled by a sensitive high-speed governor, the resistance to the movement of which is very slight. The exhaust of the high-pressure cylinder, and the admission and exhaust of the intermediate cylinder, are controlled

by a connection to a fixed point at one end of the link. These valves have a fixed travel and point of cut-off. The movements of the low-pressure valves, both inlet and exhaust, are produced by the same connection to the Fink link, and are such that when these valves are unbalanced they are motionless.

All pins and bushings in the valve gear are of hardened steel, thus reducing the wear, and rendering replacement easy.

The governor is provided with a safety device, so arranged that in case the governor belt breaks, the arms of the governor will be elevated, and the link block thrown to an extreme position, thus cutting off the supply of steam and bringing the engine to a stop.

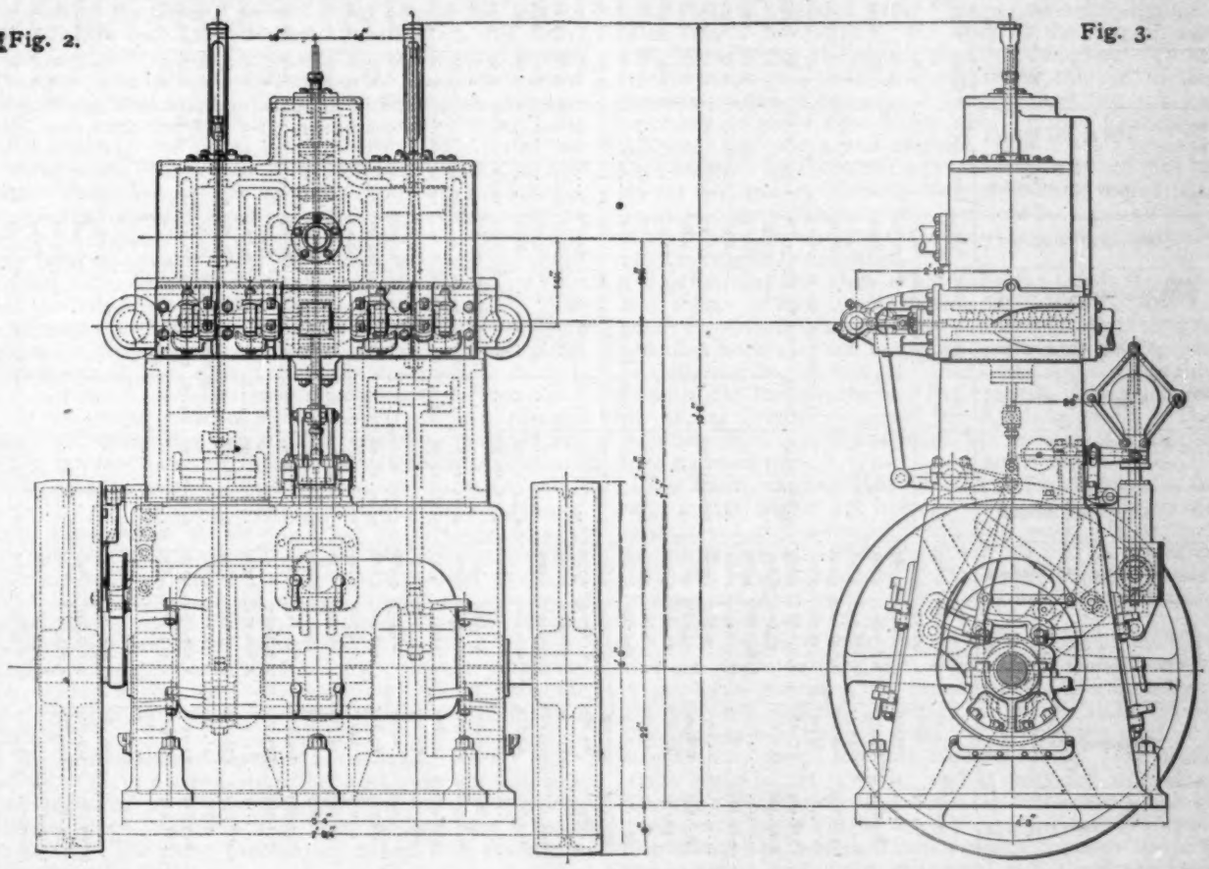
The crank shaft is forged from a solid steel ingot, and the counter-weight is bolted on. The pedestals are bored, and turned on their bases to fit a bored seat in the bed-plate or frame of the engine, to which they are secured by reamed bolts. The seats for these pedestals are bored by a single setting of a boring bar, and are consequently in perfect alignment.

Two sizes of this engine are shown in the accompanying illustrations, the one shown in perspective being of 150 indicated H.P., and the other, of which two views are given, of 250 indicated H.P. The first runs at a speed of 300 revolutions per minute, and the second at 225. It is the intention of the builders to manufacture these engines in sizes up to 2,500 H.P.

The engine described is the invention of George S. Strong, of 45 Broadway, New York, and is manufactured by the Providence Steam Engine Company, the builders of the well-known Greene automatic cut-off engine. This company believes that it is filling a long-felt need for an economical high-speed and high-class steam engine. The details of the engine have been worked out under the supervision of F. W. Dean, of Boston. With this engine a dynamo can be driven directly without the use of belts, the armatures taking the place of the fly-wheels shown in fig. 1. Its use is not by any means confined to electric work, however, but it is adapted to all purposes where a compact high-speed engine is required.

Fig. 2.

Fig. 3.



STRONG'S TRIPLE-EXPANSION ENGINE.

THE FRICK COMPANY'S SHOPS.

As it is probable that some of our readers may not know the location of Waynesboro, it may be well to explain that it is located about 25 miles southwest of Gettysburg, of historic fame, in what is known as the Cumberland Valley, which lies between the Blue Ridge and Allegheny ranges of mountains. The valley is about 35 miles wide and is of marvellous fertility. Waynesboro is a place with about 4,000 or 5,000 inhabitants, and excepting for the two great industries carried on by the Frick and another company engaged in manufacturing agricultural machinery, it is almost as quiet as the residence of Rip Van Winkle.

The Frick Company are engaged chiefly in manufacturing steam-engines, saw-mills, and refrigerating machinery. From 600 to 800 men are employed, and they have facilities for turning out large quantities of work. Located as the works are near to supplies of coal, iron and wood, and in a region where living, and consequently labor, is cheap, the cost of manufacturing is correspondingly low. They are now engaged in making a great variety of engines, including portable, traction, or self-propelling portable, stationary slide-valve and Corliss engines. The portable engines are made in sizes the cylinders of which range from 4 to 12 in. diameter, the high-

LOCOMOTIVE RETURNS FOR THE MONTH OF JUNE, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	55	37,337	70,166	39,340	146,843	2,670	....	....	64.10	81.97	42.11	66.01	...	...	5.40	4.10	0.28	0.60	6.20	2.20	18.78	....	...	....
Alabama & Vicksburg	....	14	14,828	15,164	9,667	39,659	2,833	....	....	55.71	85.11	44.24	64.10	....	....	4.50	5.60	0.27	0 70	6.20	1.80	19.17	....	....	....
Atchison, Topeka & Santa Fé	834	739	.....	.....	375,046	2,133,790	2,887	....	....	...	....	....	79.62	....	....	5.05	6.01	0.30	0.12	6.61	1.36	19.45	....	. ..	1.38
Canadian Pacific	597	....	472,674	804,692	445,141	1,722,507	2,885	. ..	....	....	....	...	58.84	....	...	3.80	10.41	0.40	....	5 35	1.26	21.22	....	1.81	3.47
Chic., Burlington & Quincy	521	....	.....	. .....	.....	1,838,543	3,145	4.98	18.35	....	....	....	80.64	....	....	4.07	5.33	0.20	0.20	6.84	....	16.64	....	...	1.30
Chicago & Northwestern	869	....	694,715	1,404,009	847,956	2,946,680	3.391	....	....	...	....	....	78.86	....	.	3.23	7.39	0.37	....	6.34	0.79	18.12	....	...	1.85
Cincinnati Southern	....	101	78,174	172,482	85,131	335,787	3,325	....	..	61.92	102.04	42.19	78.13	....	....	4.20	4.80	0.26	0.70	6.40	1.60	17.96	....	...	...
Cleve., Cinn., Chic. & St. L	....	426	444,845	576,429	371,467	1,392,741	3,269	4.70	21.90	70.25	106 50	64.90	84.00	14 94	4.86	3.23	5.33	0.21	2.47	6.39	0.23	17.86	....	....	1.26
Cumberland & Penn..	22	21	5,286	28,328	.....	33,614	1.601	....	.. .	....	....	....	75.47	.. .	...	10.30	4.10	0.40	...	....	2.00	16.80	.. .	....	....
Delaware, Lackawanna & W. Main L	208	201	....	.....	.....	679,532	3,380	....	....	..	....	....	85.11	....	....	3.27	7.02	0.42	....	5.95	....	16.66	....	....	....
Morris & Essex Division. .	157	....	166,295	252,482	8,375	427,152	2,921	....	....	....	...	....	56.16	....	...	4.17	8.74	0.37	....	6.21	...	19.49	....	....	.. .
Hannibal & St. Joseph	...	78	.....	.....	..... .	259,185	3.322	5.01	17.25	.. .	....	....	75.05	12.76	6.03	5.13	4.78	0.17	0.20	....	6.65	16.95	....	....	1.30
Kan. City, F. S. & Mem	146	....	98,471	206,538	108,438	413,441	2,832	....	....	...	....	....	54.60	....	...	3.31	4.58	0.14	0.40	7.28	....	15.71	....	....	1.62
Kan. City, Mem. & Birm	41	38	35,985	48,624	17,853	102,462	2,499	....	....	....	...	....	52.07	....	....	2.07	3.06	0.24	0.42	7.05	....	13.74	....	....	1.12
Kan. City, St. Jo. & Council Bluffs	43	43	60,305	44.275	43,462	148,042	3.445	4.95	20.81	....	....	....	60.62	12.93	4.37	3.49	4.86	0.14	0.09	6.15	....	14.76	....	....	1.78
Lake Shore & Mich. Southern	588	560	430,105	667,103	575,152	1,672,860	2,987	....	....	55.80	81.36	31.34	58.25	*	....	3.27	4.58	0.16	....	6.90	0.22	15.13	....	....	1.57
Louisville & Nashville	....	*339	431,127	785,427	414,998	1,631,542	3,627	5.00	15.79	60.47	100.82	45.30	75.62	12.11	6.18	4.30	6.39	0 26	0.42	6.11	1.55	19.03	3.20	1.48	1.69
Manhattan Elevated	....	294	746,881	.....	64,242	811,123	2,759	....	...	....	....	....	39.76	....	....	2.60	8.00	0.30	....	8,70	....	19.60	....	..	4.01
Mexican Central†	146	114	.....	.....	.....	363,834	3,192	....	.. .	...	....	....	57.31	....	....	4.62	13.82	0.46	0.17	5.54	0.89	25.50	....	....	5.38
Mil., L. S. & Western	112	101	79,675	168,186	116,216	364,077	3,605	....	....	...	....	....	69.56	....	....	3.04	9.88	0.24	....	6.16	0.88	20.20	....	....	2.85
Minn., St. P. & Sault Ste. Marie	....	....	68,027	119,670	43,763	231,460	....	4.93	18.93	....	....	....	58.32	....	....	3.96	9.61	0.21	....	6.32	....	20.10	....	1.58	...
Missouri Pacific	339	299	.....	..... .	.....	1,089,075	3,642	4.50	17.37	....	....	....	79.55	15.62	5.67	5.44	5.35	0.32	1.39	6.48	1.39	20.57	4.00	1.42	1.37
N. O. & Northeastern	.. .	28	29,394	39,829	23,419	92,642	3,309	....	....	69.93	109.29	35.40	79.36	....	....	5.70	7.60	0.27	0.40	6.20	1.80	21.97	....	....	....
N. Y., Lake Erie & Western	....	621	450,007	937,928	291,212	1,679,147	2,704	4.70	22.90	81.50	119.90	64.50	...	17.40	5.20	5.02	6.42	0.40	1.69	7.13	1.12	21.78	...	1.55	1.28
N. Y., Pennsylvania & Ohio	....	259	136,983	431,406	142,628	711,017	2,748	5.60	17.90	72.00	118.30	68.40	....	12.90	6.60	3.66	5.76	0.31	2.00	6.83	1.00	19.56	....	1.64	1.15
Norfolk & Western, Gen. Eastern Div.‡	....	143	92,630	209,181	61,107	362,918	2,538	4.80	19.50	....	...	....	95.24	....	....	6.80	2.90	0.80	....	....	....	10.50	....	...	....
Durham Division‡	....	5	7,028	12,540	2,842	22,410	4,482	4.70	3.00	...	....	....	50.00	....	...	2.00	7.00	0.50	....	....	....	9 50	....	....	....
Radford Division‡	....	48	16,876	98,719	10,615	126,210	2,629	5.10	18.20	...	....	....	124.22	...	...	8.80	5.10	0.70	....	....	....	14.60	....	....	....
Pulaski Division‡	....	28	26,109	42,972	7,907	76,988	2,745	5.00	14.20	....	....	....	99.01	....	...	8.10	4.00	0.80	....	...	....	12.90	...	....	....
Clinch Valley Division‡	....	36	20,597	45,941	18,175	84,713	2,353	3.80	11.60	....	....	....	119.05	....	....	9.70	4.70	0.90	....	...	....	15.30	...	....	....
Winston-Salem Division‡	....	10	15,669	10,611	3,354	29,634	2,963	2.30	8.50	....	....	....	68.96	....	....	2.10	6.20	2.20	....	....	....	10.50	....	....	...
Old Colony	....	230	347,264	141,503	124,656	613,423	2,667	. ..	....	....	....	....	54.29	....	....	3.15	10.18	0.63	....	6.65	0.78	21 39	....	....	3.75
Philadelphia & Reading	....	....	459,790	731,330	530,959	1,722,079	....	....	....	....	....	....	76.77	....	....	4.44	4.31	0.32	...	5.72	0 41	15.20	.. .	....	....
South. Pacific, Pacific System	705	....	.....	.....	.....	1,698,554	2,409	....	....	....	.. .	....	67.61	....	. ..	5.25	18.42	0.37	1.67	7.32	1.71	34.74	...	...	5.56
Union Pacific	995	....	712,837	1,407,852	455,304	2,575,993	2,589	5.59	16.80	....	....	....	90.09	13.99	6.97	6.86	8.56	0.43	0.80	7.92	1.06	25.63	4.28	1 85	1.98
Vicksburg, S. & P	....	15	11,314	9,729	11,390	32,433	2,162	....	....	51.02	82.64	30.53	51.68	...	....	2.90	7.10	0.22	1.20	6.70	2.30	20.42	....	....	....
Wabash	400	339	398,440	625,814	243,426	1,267,680	3,739	5.04	17.12	64.96	99.43	52.05	76.95	12.89	5.54	2.98	4.50	0.26	....	6.24	0.89	14.87	2.51	0.99	1.16
Wisconsin Central	152	126	134,027	211,415	79,525	424,967	3,373	....	....	...	....	....	73.37	....	....	3.15	9.42	0.23	....	7.23	....	20.03	....	....	2.50
Year ending June 30.																									
Atchison, Topeka & Santa Fé	834	718	.....	.....	4,079,383	24,931,357	34,723	....	....	..	..	.. .	80.87	....	....	5.16	6.79	0.29	0.15	6.58	1.52	20.49	....	....	1.63
Kansas City, Ft. Scott & Memphis	....	145	1,172,247	2,669,783	1,325,961	5,167,991	35,646	....	....	....	....	....	61.46	....	....	3.59	5.33	0.25	0.51	7.24	....	15.92	....	....	1.68
Kan. City, Mem. & Birm	41	41	428,723	679,699	156,873	1,265,295	30,885	....	....	....	....	....	64.04	....	....	3.11	3.62	0.29	0.43	7.05	...	14.50	....	....	1 09
Old Colony	....	218	3,989,836	1,536,438	1,449,032	6,975,306	31,997	....	....	....	....	....	57.54	....	....	3.24	11.16	0.62	....	6.75	0.80	22.57	....	....	3.88
Wabash	400	349	4,825,838	8,307,110	3,071.882	16,204,830	46,432	5.00	17.72	66.20	102.20	53.94	82.43	13.32	5.76	3.11	4.77	0.29	....	6.23	0.86	15.26	2.66	0.98	1.16

Note.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 18.5 units of work per $1 of expense; 184.1 units of work per ton of coal; 10.86 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

speed engines from 5 to 14 in., and the Corliss machines from 10 in. up to anything. Thus far the largest size made has been 44 in.

The traction engines are provided with wrought-iron channel-bar frames, one on each side of the fire-box running parallel with it. In front of the fire-box they are curved inward, until they almost join, and are bolted to each other, and extend to the front axle saddle-block, to which they are riveted, the front end of the boiler resting upon the saddle-block. These channel-bars form the foundation of the whole system. They are rigidly connected to the boiler at only one point in their length, expansion pieces being bolted to the boiler, in front of and behind the rigid connection, which, while engaging the upper part of the saddle and preventing side-play, allow for expansion and contraction of the boiler by permitting of end-play. The channel-bars back of the fire-box are connected with each other by cross-plates. The fire-boxes have water bottoms, and a belly girth or band is riveted to the channel-bars and passes under the fire-box, thus supporting the boiler. In order that the under side of the fire-box may have a perfect bearing on this belly-band, soft melted metal is poured into the space between the two. The boiler is thus supported on the belly-band and on the front saddle. To support the engine and gearing, and keep the straining action of the working parts from affecting the boiler, strong vertical side-plates are riveted to the channel-bar frames on each side of the fire-box. These support the axle and crank-shaft bearings, and extend upward so as to receive the crank end of the engine bed-plate. This is in the form of an arch extending from one plate to the other and over the top of the boiler. The front end of the engine bed-plate simply rests on the boiler on a freely sliding expansion joint. The channel-bars thus form a complete frame, which rests on the main driving and front wheels; the vertical side plates being raised high enough to carry the engine, which is located above the boiler, and is bolted to these plates.

If the driving power of an engine is transmitted through the rigid connection of a train of gearing to the main axle there is great liability to break. For this reason an elastic compensating gear has been devised and patented, and is used by the Frick Company, for driving their machines. The construction of this could not be explained so as to be clearly understood without the aid of an engraving. It must suffice, therefore, to say that the power of the engine is transmitted to the wheels through the medium of spiral springs, which effectually cushion all sudden shocks and insures smoothness of action.

The valve-gear consists of a loose eccentric, which can be shifted on the axle. An engraving would, however, be required to explain the mechanism by which this is effected.

A great variety of forms of portable engines are made; some of them are self-propelling and some are not, some are mounted on wheels, and others have only a wooden frame which facilitates their removal from one place to another. The same engines are made with frames intended to be stationary.

The line of high-speed, automatic cut-off engines, as already remarked, includes sizes varying from 5 to 14 in. in the diameter of the cylinders. These have Professor John E. Sweet's balanced slide-valve, which is controlled by a "regulator," which is secured to the crank-shaft of the engine, and all the mechanism is contained within a small driving pulley. The parts consist of two pivoted levers, provided with weights; these are connected to each other and to an adjustable counterbalanced shifting eccentric by links. The eccentric is so arranged that it adjusts the movement of the balanced slide-valve in the steam-chest, and controls the distribution of steam to the piston from zero to nearly full stroke. The maximum number of revolutions at which the smaller sizes of these engines will run is 337 and the larger sizes 240.

The plain slide-valve engines have Corliss girder bed-plates with the steam-chests on the sides of the cylinders, the valves being connected directly to the eccentrics. Besides these engines the Company makes upright engines adapted for rolling-mills and grain-elevators. These are made either with the ordinary slide-valve or with Professor Sweet's valve and an automatic regulator or with the Corliss valve-gear.

Mr. Edgar Penney, the Mechanical Engineer and General Superintendent of the Frick Company, occupied for some years an important position with the Corliss Steam Engine Company of Providence, R. I., and in that connection had large experience in designing, testing, and experimenting upon all types of Corliss engines, an opportunity presented to but few in the business. The Frick Company, therefore, claim that they are making the genuine, standard Corliss engine, as finally developed and improved by Mr. Corliss. These engines are made with horizontal and vertical cylinders and frames, compound and non-compound, and condensing or non-condensing.

Compound engines are made of the "tandem" type or with the cylinders side by side, and connected to cranks at right angles to each other on opposite ends of the main shaft.

It would be impossible to give any satisfactory account of the refrigerating and ice-making machinery manufactured by the Frick Company without occupying more space than is available here. There was an 85-ton machine nearly completed in the shop at the time of our visit, intended for the Moore Packing Company. Three other 200-ton machines have just been shipped to the Armour Packing Company, of Chicago, and two 100-ton machines to the Union Stock Yards at San Francisco. All these had compound engines. The Frick Company have patterns for machines with a capacity of 200 tons of ice per day, but would build them of 600 tons if required. The Company publishes a very excellent book on this kind of machinery, in which the theory and practice of refrigeration is very fully explained.

The machine tool shop is 300 × 60 ft.; this is the original shop. A new erecting shop 260 × 30 ft. with an annex 80 × 50 ft. has just been completed. This shop is provided with a 15-ton traveling crane with two speeds on hoist and two on bridge. This crane was built by this Company in its own shops. Besides this there are three jib cranes driven by power for handling work. The grinding shop is in a basement, but is not yet equipped with its machinery.

The main erecting shop for heavy machinery is 45 ft. wide × 45 ft. high × 315 ft. long. A 25-ton traveling crane is employed in this shop for handling work. In one end of this shop a pit lathe, which will turn 40 ft. diameter and 10 ft. face, is provided for finishing large fly-wheels, pulleys, and other work. It is of very simple construction, but apparently very efficient.

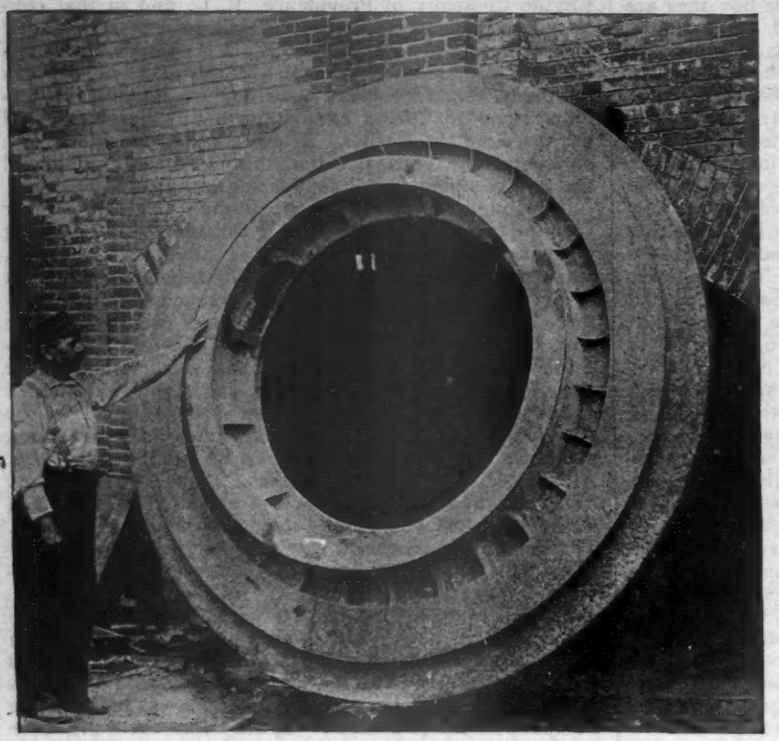
The shops are driven by three engines, one of 200 H.P. and the other two of 75 H.P. each; 450 incandescent and 30 arc lights are used for illumination. The foundry is 100 × 150 ft. with five jib cranes, and a new 25-ton traveling crane is now being erected. It is proposed to build a new foundry 120 × 400 ft. in the near future. The blacksmith shop is 125 × 50 ft., and is provided with three Bement steam hammers, and a scrap furnace in which all their own scrap is worked up. The heat from this furnace is conducted to a vertical boiler which supplies steam to the hammers, and is also connected with the general system of steam-pipes in the shop.

The boiler shop is 100 × 123 ft. All riveting is done by hand. The caulking is done with the tools of the Pneumatic Tool Company. The tubes are also beaded with this same machine. All the pipes used in refrigerating machinery are tested under water in this shop with air pressure. Any leak is thus detected at once. The connections are made of tapered screw joints, which are cut with great care so as to insure accuracy. Before being screwed together they are cleaned with benzine and are then painted with a mixture of glycerine and litharge, which forms a satisfactory cement. Flange joints are made with a ring of soft lead which is held in grooves turned in the flanges.

The wood-working shop is 100 × 125 ft. The saw-mills made by this Company would require more room to describe than is available here. Altogether the shops are very well arranged and equipped, and the Company has been wise enough to publish a number of excellent descriptive pamphlets describing their products which can be obtained by any one interested therein.

A Remarkable Steel Casting.

THE accompanying engraving is from a photograph of a very remarkable steel casting recently made by the Midvale Steel Company in Philadelphia. This casting is for the roller path for the 8-in. disappearing gun carriage built by the Ordnance Department of the United States Army; it is notable not only on account of its great size and weight—7,995 lbs. shipped—but also for the high grade of metal used.



A REMARKABLE STEEL CASTING.

The specifications of the Ordnance Department, under which this casting was made, called for a tensile strength of 65,000 lbs. per square inch, with an elongation of 20 per cent.; the minimum allowed was 55,000 lbs. tensile strength and 15 per cent. elongation.

The official test of the casting, on a test-bar 0.505 in. diameter and 2 in. long between measuring points, showed the following results: Tensile strength, 73,000 lbs. per square inch; elastic limit, 35,500 lbs.; elongation, 33.20 per cent.; contraction, 47.18 per cent.

It is especially to be noted that the test showed an elongation 66 per cent. above that required by the specification, and 120 per cent. above the minimum allowed.

Foreign Naval Notes.

A DUTCH COAST-DEFENSE SHIP.

THE accompanying illustrations, from *Industries*, show the coast-defense ship *Reinier Claeszen*, recently launched from the navy yard at Amsterdam, Holland. She will be ready for service during the present year. Her principal dimensions are: Length between perpendiculars, 217 ft.; length over all, 230 ft.; breadth, 44 ft. 4 in.; molded depth, 16 ft. 7 in.; with a displacement of 2,490 tons on a mean draft of 14 ft. 5 in. The fore and aft parts of the vessel have comparatively little freeboard—only about that given to a monitor—but for a part of her length it is greater. All the vital portions are protected by a steel deck and a belt of compound armor plates, both running the whole length. The deck in the middle is 1 ft. 2 in. above and at the sides, 3 ft. 7 in. beneath the load water line. The compound plates, made by John Brown, of Sheffield, are 4¾ in. thick over a length of 95 ft., and fore and aft 4 in. thick, with a teak backing of about 6 in. The vessel is provided with a double bottom extending over a length of 120 ft., and between the upper and protective decks a cellular construction has been adopted, the outer cells being filled with cellulose. Seven transverse bulkheads divide the hull into water-tight compartments, and a longitudinal bulkhead divides the engine and boiler rooms. Steel has been exclusively adopted in the construction, the stem and stern ports, rudder frame and supports of the screw shafts being cast.

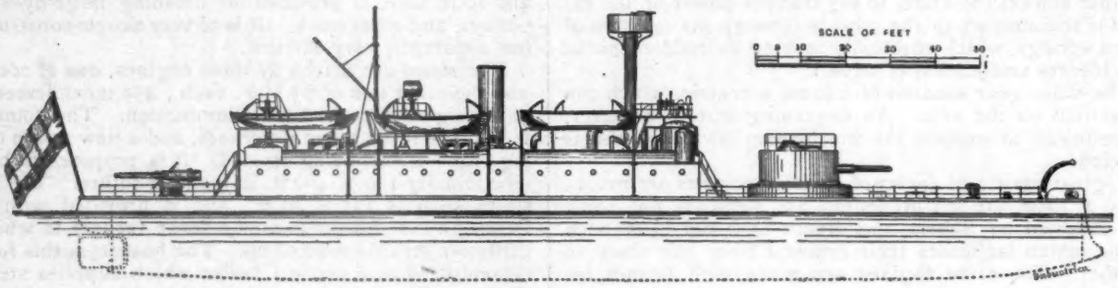


FIG 1.—GENERAL ELEVATION OF VESSEL.

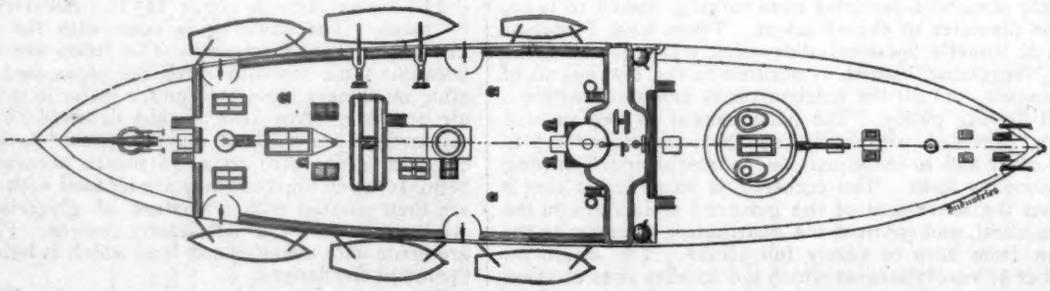
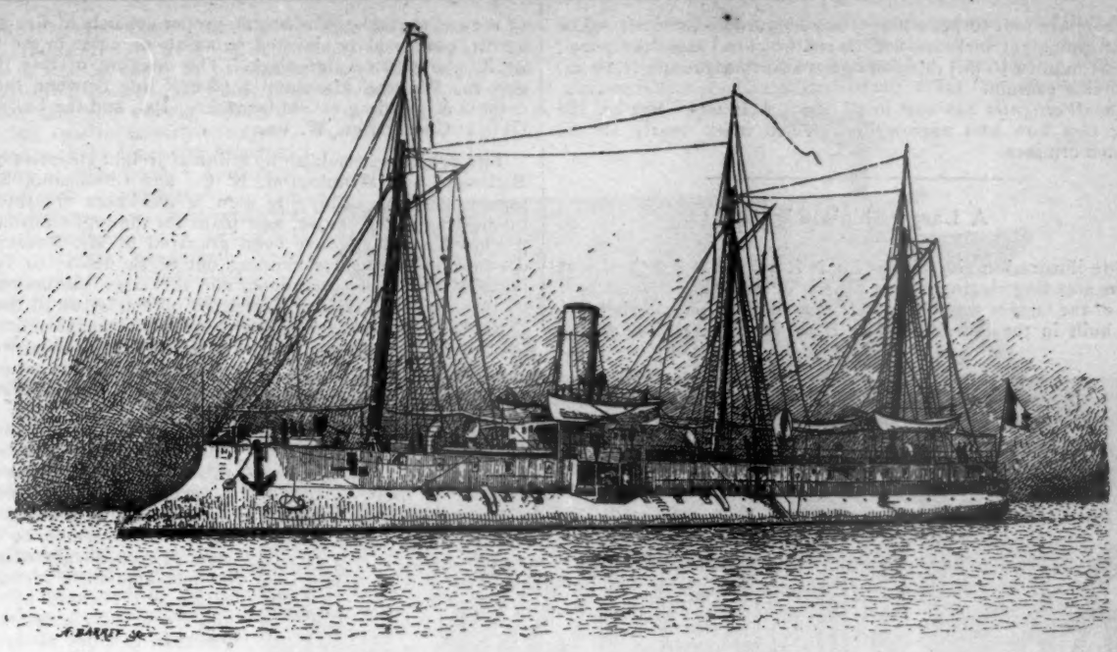


FIG 2.—GENERAL PLAN

[COAST-DEFENSE SHIP FOR THE DUTCH NAVY.

The armament consists of two Krupp guns, one 8¼ in. and one 6¾ in., both 35 calibres long; four quick-firing Krupp guns of 2 in. on the bridge deck, and two quick-firing 1½ in. guns



TORPEDO GUNBOAT "WATTIGNIES," FRENCH NAVY.

in the military top. Two torpedo guns are placed in the broadsides, and fire over a range of 75°. The 8¼-in. gun is placed forward in an armored turret, consisting of a fixed and a revolving portion, both covered with 11 in. compound plates having a teak backing 8⅝ in. thick. The fixed part of the turret is fitted on the protective deck, and hand and steam gearing is provided, by means of which the movable portion can be rotated. The 6¾ in. gun firing backward is to be placed on a central pivot and protected. The commander's house is cylindrical in form, and protected by 11 in. compound armor plates.

The twin-screw propellers are driven by vertical triple-expansion engines, having cylinders 20 in., 30 in., and 50 in. diameter respectively, with a stroke of 19 in. They are to be capable of developing 2,400 H.P. at 190 revolutions, and with steam of 170 lbs. pressure. The condensers are cylindrical, with a cooling surface of 3,800 sq. ft.; the centrifugal circulating pumps, delivering 360 tons of water per hour, are independent of the main engines, and may also be used as bilge pumps. The crank and propeller shafts are of steel, and the propeller blades of Delta metal. The propellers are four-bladed, and are 8½ ft. diameter, with a pitch variable between 8 ft. and 10 ft. The boilers—three in number—are single-ended, and of steel, each having two Purves' flues. The boilers are 17 ft. long, with a diameter of 8½ ft., and are intended for forced draft. The engines and boilers are being constructed by the Royal Schelde Company, of Flushing.

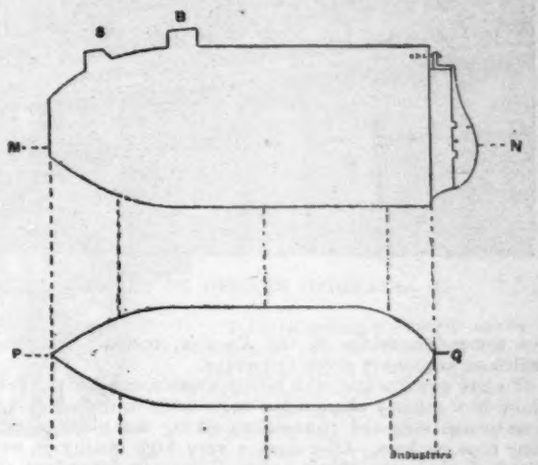
A SUBMARINE BOAT.

THE accompanying illustrations, figs. 2, 3 and 4, represent diagrammatic sections of a novel form of submarine vessel recently launched from the yard of Messrs. Migliardi & Vene, of Savona, Italy, which has been designed by Messrs. Pietro degli Abbati & Sons, and which is being introduced by a company entitled the Società Romana per la Pesca e Ricupero dei Valori Subacquei. The vessel, which is of steel, is 28 ft. long, 6¼ ft. broad, and 9¼ ft. deep, and is provided with a screw propeller actuated by an electromotor. Referring to fig. 2, *B* is the manhole through which the crew, consisting of five men, enter the vessel, and *S* are the port-holes fitted with strong glasses. On the left-hand side of the hull near the stern a door is provided which may be opened from the inside when under water for allowing exit to divers, without admitting water into the vessel. The hull is provided with three watertight compartments, and it is estimated that the crew will be able to remain under water for a period of 48 hours.—*Industries*.

A FRENCH TORPEDO-CRUISER.

THE illustration given herewith shows the French torpedo-cruiser *Wattignies*, which recently received her preliminary trials. The ship was designed by Inspector-General de Bussy, of the French Navy, and was built at Rochefort; the engines and boilers were built at the Schneider Works at Creusot.

The twin screws are driven by two engines, which on the last trial worked up to 4,200 H.P., giving the ship an average speed of 18.6 knots an hour. There are four tubular boilers, each with two furnaces. The coal bunkers hold 160 tons, which



FIGS. 2 AND 3.—LONGITUDINAL SECTIONS OF HULL.

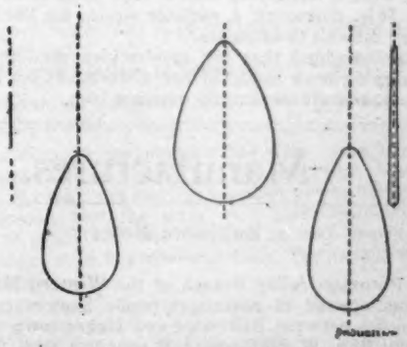


FIG. 4.—TRANSVERSE SECTIONS OF HULL.

is sufficient for 552 knots at full speed, or for 1800 knots at a 12-knot rate.

The general dimensions are: Length, 229.6 ft.; breadth, 29.2 ft.; draft forward, 11.4 ft.; draft aft, 15.4 ft.; displacement, 1,306 tons.

There are four torpedo-tubes, two forward and two aft. The other armament includes five 10-cm. (3.93-in.) rapid-fire guns; two 65-mm. (2.56-in.) rapid-fire guns and four 37-mm. (1.46-in.) revolving cannon.

The *Wattignies* has cost in all about $580,000. She has the long ram bow and narrow deck which mark nearly all the French cruisers.

A Large Ship's Rigging.

THE illustration given herewith is from a photograph of part of the standing rigging of the American built ship *Shenandoah*, one of the largest wooden vessels ever built. The *Shenandoah* was built in the Sewall yard at Bath, Me., and was of nearly

STANDING RIGGING OF THE SAILING SHIP "SHENANDOAH."

the same dimensions as the *Roanoke*, recently launched, of which an account is given elsewhere.

To any one familiar with sailing-vessels, the photograph will show how great a change has been made in their rigging, the iron turnbuckles and connections taking the place of the old-time rope gaskets. Of course a very high quality of work is required, since the ship's safety is largely dependent on the excellence and holding power of the rigging, and the strain put upon it with a large ship and a high wind is sometimes very great. It is, moreover, a variable strain, the amount of which it is very difficult to calculate.

It may be added that the turnbuckles used on the *Shenandoah's* rigging were made by the Cleveland City Forge & Iron Company, and are of pressed wrought iron.

Manufactures.

Baltimore Notes.

THE Potomac Valley Branch of the Western Maryland Railroad was opened to passenger traffic September 12, and the train service between Baltimore and Hagerstown was extended to Cherry Run, W. Va., where it connects with the Baltimore & Ohio main line. The road consists of 14.3 miles of main track, with 2 miles of sidings; it is substantially built; all bridges are of iron, supported upon first-class masonry, and heavy steel rails and stone ballast have been used throughout. The bridge over the Potomac River, with its trestle approaches, and the iron span over the Chesapeake & Ohio Canal, represent a cost of about $100,000, or nearly one-fourth of the cost of the entire road. The bridge proper consists of five spans of 140 ft. each, and is elevated to admit of a rise in the river of 45 ft. above low-water mark. The opening of this line will give the Western Maryland a 66-mile line between the Philadelphia & Reading at Shippensburg, Pa., and the Baltimore & Ohio at Cherry Run, W. Va.

THE project of establishing a line of freight steamers between Baltimore and Wilmington, N. C., and Charleston, S. C., is assuming shape. Shipping men in Baltimore are interesting themselves in the matter, and plans for the organization of the proposed company have been prepared by Mr. James B. Andrews. The only line running out of Baltimore to Southern ports is the one to Savannah, and the large business handled by this company should furnish an object lesson of the possibilities at other coast towns with suitable transportation facilities. By the plan now under contemplation it is proposed to establish a line of first-class steamers to run semi-weekly between Baltimore and Wilmington and Charleston. For this service three boats will be necessary. The steamers are to be not less than 1,500 tons each. They are to be built of steel or iron, furnished with all modern appliances for handling cargo and anchors by steam, and are to have a speed of not less than 12 miles an hour. It is estimated that such steamers as contemplated will cost $150,000 each. The company to operate the line and build the boats is to be organized with a large capital stock. The steamers are to be constructed expressly for freight boats, with no passenger accommodations. The money that would be applied to passenger accommodations, which are usually costly, is to be expended in perfecting every practical modern working device that will tend to improve the steamers and enhance the trade in which they will engage and in cheapening the cost of labor in handling freight.

THE directors of the City Passenger Railroad Company have awarded a contract for 62 grip and trail cars for the Red, White, and Blue cable lines to the J. G. Brill Company. The grip cars will be constructed with the grips in the middle instead of at the ends. This will enable a car to be run in opposite directions without the use of a loop at the terminus of the line, or without turning the car, as it is intended to construct the cable lines of the City Passenger Railroad Company without loops. The cars will be similar to those in use in Washington.

THE South Baltimore Car Works have completed 650 Lumber Line box cars for the Baltimore & Ohio, and they are now working on a lot of 350 of the same kind of cars for the West Virginia & Pittsburgh. These cars have automatic couplers, full height end doors, and are designed for the lumber trade in West Virginia.

THE Baltimore & Ohio is having some additional refrigerator cars thoroughly repaired and rebuilt at the South Baltimore Car Works.

THE Baltimore & Ohio Southwestern contemplates building some coal cars, but the contract has not yet been received.

Boiler Pitting Cured by Graphite and Oil.

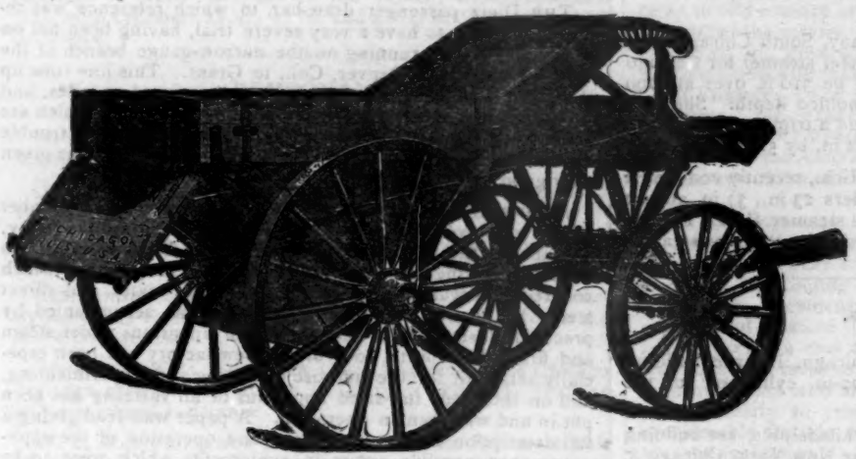
IN the *American Machinist* of July 28, Mr. T. T. Parker has a very interesting article regarding pitting in boilers. Besides some theories, he has this to say from a practical point of view: "In a boiler of the porcupine persuasion pitting was found in the mud drum. Acting under advice, the drum was cleaned and scraped, after which it was painted with graphite mixed with cylinder oil. Measurements of the depths of the pits were taken, and six months after they were found no deeper, and no new ones had shown up. Other parties have since tried this

experiment in mud drums, but it is too early as yet to give the result. However, knowing the character of plumbago, if the interior of a boiler could be painted with it in such a way that it would stay it may be this would prove a remedy. I am satisfied also that the person doing so would kill two birds with one stone, as the scale could be easily detached. In a pair of cylindrical boilers 42 × 28 occasional applications of cylinder oil (mineral) and plumbago have kept back corrosion on a trial of six months. Boilers were new when plumbago was used. The boilers which the new ones replaced were thrown out rotten from corrosion. The feed was mine water, as nothing else could be had.'

In addition to Mr. Parker's remarks we add that Harig, Koop & Company, Louisville, Ky., after experiencing more or less trouble from rust and scale in the mud drums of their boilers, applied with great success graphited oil, purchased from the Joseph Dixon Crucible Company, Jersey City. The mud drums were cleaned out and the graphited oil applied with swab, brush, or anything handy, to the joints and parts where the water enters the drums. Every four or six weeks this process is repeated with the most gratifying results.

The Austin Dump Wagon.

THE dump wagon is not so generally employed as its usefulness deserves, due probably to the fact that until now a satisfactory dump wagon has not been produced. The accompanying picture illustrates a dump wagon manufactured by the



THE AUSTIN DUMP WAGON DUMPED.

F. C. Austin Manufacturing Company, of Chicago, Ill., who claim that it possesses all the desirable features of a dump wagon—it is easily and quickly dumped, is strongly made, and can be turned short.

To contractors and others having large quantities of earth to move and haul long distances beyond the range of the drag scraper, the dump wagon is almost indispensable. There is a great saving of money and time in its use as compared with an ordinary wagon with dump boards. The great disadvantage of handling earth on common wagons is the time consumed and the employment of an extra man at the dump.

Aside from earth-work the dump wagon is employed for hauling crushed stone, brick, sand, street sweepings, etc.

On earth-work the maximum saving is made when loading dump wagons by the "New Era" grader, a machine (also manufacturered by the Austin Company) consisting of a transverse carrying belt which receives the earth from the plow and delivers it into the wagon direct. This New Era machine is capable of loading 600 to 800 wagons with 1¼ to 1½ yards each in 10 hours, with a working force of six teams and three men. Contractors generally figure that for a haul of 50 to 75 ft. or less drag scrapers are best employed; over that distance, to say 300 ft., wheel scrapers; and for a longer haul, wagons. The Austin dump wagon, when loaded by the New Era grader, will move earth more cheaply for a distance exceeding say 50 ft. than wheel scrapers or any other method. It will be readily seen that if the plow of the New Era cut 8 in. deep (under favorable circumstances it will cut 12 in. deep) every foot of driving ele-

THE AUSTIN DUMP WAGON.

vates and loads two-thirds of a foot, and 60 ft. of driving loads a wagon of 1½ yards. The speed of teams at heavy work is 150 ft. per minute, and the New Era will load 2½ wagons per minute, which brings the cost of loading down to less than 2 cents per cubic yard. By actual test the New Era grader has loaded 150 wagons per hour for several hours.

The wagon being loaded at an expense of 2 cents a cubic yard, careful estimates show that the cost of loading scrapers, either drag or wheelers, is much more, and when a team and driver have a given distance to haul, if a drag scraper it moves one-quarter, if a wheeler one-half yard; while the dump wagon takes out three times as much as a wheeler, or at one-third the cost. The arrangement of the wagon will be readily seen from the engraving.

Tests of Meneely Tubular Bearings.

THE following statement shows the result of comparative tests made by the Delaware & Hudson Canal Company, September 14–17, 1892, with Belt Line trains of four cars, each train weighing 102 tons; trains drawn by engine No. 134.

The coal test showed the following result:

Brass Bearings:
Consumption in running 18 round trips (270 miles) 14,800 lbs.
Tubular Bearings:
Consumption in running 18 round trips (270 miles) 11,100 "

Excess of consumption with brass bearings, 33⅓ per cent..... 3,700 lbs.

The dynamometer test showed that with brass bearings the power required to start train was 3,276 lbs.; with tubular bearings it was 252 lbs.; the ratio of required power being 13 to 1.

In the gravity test, the train with brass bearings, the run from foot of grade was 100 ft.; with tubular bearings it was 534 ft., or more than five times as far. The results shown are very remarkable.

Lake Ship Building.

THE Globe Iron Works Company, Cleveland, O., has just completed the steel steamer *Mariposa* for the Minnesota Steamship Company. The general dimensions of the *Mariposa* are 353 ft. over all, 335 ft. keel, 45 ft. beam and 24 ft. 6 in. molded depth. Her estimated carrying capacity is 4,000 tons on a draft

of 16 ft.; speed, 14 miles an hour; engines, triple expansion; diameter of cylinders, 24, 39 and 63 by 48 in. stroke; three Scotch type boilers 12 × 12 ft., tested for 175 lbs. steam; and the usual auxiliary machinery and modern equipment, including an electric light plant. The steam windlass, capstans and steam steering gear, as well as the main engines and boilers, propeller wheel, etc., are all from the works of her builders. The *Maritana*, a sister ship, recently took the largest cargo on record on the lakes, carrying 4,218 tons of iron ore from Escanaba on 17 ft. 6 in. draft.

PLANS have just been completed by the Detroit Dry Dock Company for the two side-wheel steamers they will build for the Detroit & Cleveland Steam Navigation Company, to take the place of the *Alpena* and *Mackinaw*, sold to Cleveland parties recently. The *Review* is favored with the first information concerning them. They will be 264 ft. on the water-line, 38 ft. beam, 69 ft. over the guards, and 15 ft. deep. The length is about 6 ft. and the beam 3 ft. less than the *City of Cleveland*, the furnishing, fittings, finishing, and general arrangement of which will be duplicated in the new boats. The engines will be walking-beam compound, built by Fletcher, New York, the high-pressure cylinder being 42 in. diameter by 7 ft. 5 in. stroke, and the low-pressure cylinder 66 in. by 11 ft. stroke. Steam will be supplied by four 11 × 11-ft. boilers, an important auxiliary being furnished in Howden's system of forced draft. This will result in the boats being faster than the two running between Detroit and Cleveland, which make 18 miles an hour when desired. While the builders are very conservative, it is thought that they will not object to the statement that the new boats will make 19 miles an hour. The most peculiar thing about the new boats is that each will have a rudder in the bow—not in front of the bow. As far back as 8 ft. the stem of these boats will not be over 12 in. thick, and the rudder will consist of a portion of the stem being fixed so that it will swing to port or starboard, as desired. This will enable the boats to run up the river at Alpena or Cheboygan, or into any harbor, and back out without the aid of a tug. It is a valuable contrivance, and there is no reason why it will not work.—*Cleveland Marine Review.*

THE Chicago Ship Building Company, South Chicago, Ill., has taken a contract to build a large steel steamer for Chicago parties. The general dimensions will be 310 ft. over all, 290 ft. keel, 41 ft. beam and 24 ft. 8 in. molded depth. She will have two Scotch boilers 12 × 12 ft., and a triple-expansion engine with cylinders 19 in., 32 in. and 52 in. by 52 in. stroke.

THE Frontier Iron Works, Detroit, Mich., recently completed a triple expansion engine, with cylinders 23 in., 37 in. and 62 in. in diameter by 44 in. stroke, for the steamer *W. H. Gilbert*, and are building another of the same size for the new steamer *Pathfinder*.

General Notes.

THE Grant Locomotive Works, Chicago, Ill., are building five switching engines, with 16 × 22-in. cylinders, for the Chicago, Milwaukee & St. Paul road.

THE Baldwin Locomotive Works, Philadelphia, are building 10 ten-wheel freight locomotives for the New York, Chicago & St. Louis Railroad. Nine of them have 18 × 24-in. cylinders; the remaining one is a four-cylinder compound engine of the Vauclain type. These shops have also recently taken contracts for two simple and two compound freight engines for the Toledo, Ann Arbor & Northern Railroad, and for 10 compound consolidation engines for the Lehigh Valley Railroad.

THE Cooke Locomotive Works, Paterson, N. J., are building three standard passenger engines and one heavy switching engine for the Delaware, Lackawanna & Western Railroad.

THE lubricating pads of the Automatic Lubricator Company have had a successful trial on the Pennsylvania Company's lines. The New York, New Haven & Hartford Company has recently ordered 1,800 to complete the equipment of its locomotives and tenders.

THE Pullman Shops, Pullman, Ill., recently delivered 15 first-class passenger and two combination cars to the Chicago, St. Paul, Minneapolis & Omaha Railroad. These cars are equipped with steam-heating apparatus and Pintsch gaslights, and have Scarritt-Forney seats.

THE Lodge & Shipley Machine Tool Company has been organized in Cincinnati with $100,000 capital stock, the officers being William Lodge, President and General Manager; Murray Shipley, Jr., Vice-President and Secretary. The new company succeeds to the plant and business of the Ohio Machine Tool Works, owned by Mr. Lodge, and will manufacture turret lathes of a new special pattern, besides a variety of lathes and other tools and special machinery for boring and turning pulleys, couplings, and similar work.

THE firm of Westinghouse, Church, Kerr & Company, Engineers, have closed an important contract with the Standard Refrigerating Company of Boston. This Company is the manufacturer of the Hodges & Havenstrite system of refrigeration and ice-making, and Westinghouse, Church, Kerr & Company have secured exclusive control of the sale of this apparatus in the United States, which they have added as a separate department to their contracting business. A large number of orders, particularly in the direction of manufacturing artificial ice, are already booked, and the work is under construction.

THE firm of B. M. Jones & Company, of Boston and New York, are now furnishing the brand of "R. Mushet's special" steel in annealed blanks for use in milling cutters, taps and dies, reamers, twist drills, and similar purposes. The quality and uses of this brand are well known.

THE shops at Hegewisch, Ill., and at Anniston, Ala., formerly owned by the United States Rolling Stock Company, have been turned over to the new corporation which has been formed to carry on the business of that concern, and which is known as the United States Car Company. Mr. George W. Ristine, who is well known among railroad men, has been chosen President of the new company.

THE E. P. Allis Company, Milwaukee, Wis., has the contract for the engines in the new power-house of the electric railroad in Brooklyn, N. Y. It includes six compound engines with cylinders 32 in. and 62 in. × 60 in., which will work up to 2,000 H.P. each, and eight compound engines, with cylinders 26 in. and 48 in. × 48 in., which will work up to 1,000 H.P. each. The working pressure will be 140 lbs. The engines will be connected directly to the dynamos, the armatures taking the place of the fly-wheels of the engines.

THE Dietz passenger draw-bar, to which reference was recently made, is to have a very severe trial, having been put on a passenger train running on the narrow-gauge branch of the Union Pacific from Denver, Col., to Grant. This line runs up the Platte Cañon, rising 4,000 ft. in a distance of 40 miles, and is almost a constant succession of curves, many of which are very sharp. On this line there has been considerable trouble with trains breaking in two. So far the new coupler has given very good results.

A CONFERENCE or convention was held recently by a number of the employés of the Consolidated Car Heating Company, who met at the new factory in Albany, N. Y., and spent two days in carrying out a carefully arranged programme, which covered a discussion of the theory of hot water and direct steam heating in all its branches, and was accompanied by practical illustrations of the working of apparatus under steam and fire. The fourth floor of the new factory has been especially arranged for the purpose of testing and experimenting, and on this floor full-sized apparatus of all varieties has been put in and was seen in operation. A paper was read giving a full description of the construction and operation of the appliances, then possible errors in equipment, which were to be guarded against, were pointed out, and following this questions were asked by all present. Advance sheets of the Company's new catalogue were submitted, and several new devices which are to be put upon the market this season were exhibited and discussed.

Lunch was served each day in the offices of the Company. Part of the time was spent in the careful consideration of the present aspect of business, and encouraging reports were received from all directions.

THE car works of Murray, Dougal & Company, Milton, Pa., are completing an order for 1,000 double-hopper gondola cars for the New York Central. They are also building a lot of oil-tank cars.

THE Berlin Iron Bridge Company, of East Berlin, Conn., is putting up two iron buildings for the Randolph & Clowes Company, at Waterbury, Conn., one a casting shop 42 ft. wide by 82 ft. long, and another a pickle room 25 ft. wide by 100 ft. long. The Berlin Company is also building a new gas house for the Philadelphia & Reading Railroad at Philadelphia, and a new retort house for the George H. Morrill Company, of Boston. All of these buildings are to be of iron, after the well-known plans of the Company.

THE new foundry and warehouse now being built by the Westinghouse Air Brake Company, at Wilmerding, Pa., were

to be completed and ready for operation by October 1. About 600 additional men will be given employment in the new foundry as soon as it is completed.

THE Berlin Bridge Company has the contract for a new bridge over the Connecticut River at Suffield, Conn. It will have five spans of 210 ft. each, and will carry a roadway 20 ft. wide.

THE Midvale Steel Works, Nicetown, Philadelphia, are building a new machine shop 20 × 112 ft. in size, which will contain some very heavy tools, including a lathe which will carry work 90 in. in diameter and 50 ft. long between centers. It will be used chiefly on heavy Government work.

THE largest wooden sailing ship ever built in the United States was recently launched from the Sewall yard at Bath, Me. She is named the *Roanoke*, and is 311.2 ft. long, 49.2 ft. beam, 29.2 ft. deep, and is of 3,530 tons measurement. She has four masts.

THE Harlan & Hollingsworth Company, Wilmington, Del., recently completed the twin-screw steamer *Richard Peck* for the line between New York and New Haven. On her trial trip this boat attained a speed of 20¼ miles an hour. The dimensions of this steamer are: Length on water-line, 300 ft.; length over all, 316 ft.; breadth of beam on hull, 48 ft.; breadth over guards, 62 ft.; depth of hold, 18½ ft.; draft, 10½ ft. She has two triple-expansion surface-condensing engines, with a diameter of cylinders of 60, 38 and 24 in., 30 in. stroke. Steam is furnished by six steel Scotch boilers, 12 × 12 ft., with 400 ft. of grate surface. She is handsomely fitted up and lighted by electric light.

THE latest addition to the fleet of propellers on Long Island Sound is the *Nutmeg State*, built for the Bridgeport Line by Robert Palmer & Sons, of Noank, Conn. She is 200 ft. long over all, 183 ft. on water-line, 34 ft. beam and 9 ft. mean draft. She has ample accommodations for passengers. There are two steel boilers 9 ft. 4 in. diameter and 20 ft. long, each having two corrugated furnaces. The engines, built by J. W. Sullivan, of New York, are of the vertical triple-expansion type, with cylinders 18 in., 27 in. and 42 in. in diameter and 28 in. stroke.

PERSONALS.

A. B. PALMER has been appointed Superintendent of Water-Works at Green Bay, Wis.

DANIEL W. SHEA, recently of Harvard, has been appointed Professor of Physics in the University of Illinois.

WILLIAM J. GILLINGHAM, JR., has been appointed Signal Engineer of the Illinois Central Railroad, with office in Chicago.

COMMANDER FRENCH E. CHADWICK, U. S. N., has been assigned to the charge of the Bureau of Naval Intelligence in the Navy Department.

BENEZETTE WILLIAMS is now Chief Engineer of the Chicago drainage canal, with THOMAS T. JOHNSON and B. C. DUNLAP as his principal assistants.

W. T. MANNING is now Chief Engineer of the Baltimore Belt Line, succeeding MAJOR RICHARD RANDOLPH, who has been appointed Consulting Engineer.

PROFESSOR ARTHUR T. WOODS, recently of Washington University, in St. Louis, is now connected with the *Railroad Gazette*. He will have his office in Chicago.

CHARLES L. HEISLER, M.E., has given up his office as Consulting Engineer in Dunkirk, N. Y., and is now connected with a large manufacturing concern in Philadelphia.

WILLIAM H. BURR, formerly Professor in the Rensselaer Polytechnic Institute, but for some years past in active practice as a civil engineer, has accepted a professorship in the Lawrence Scientific School of Harvard University.

CHARLES W. SCRIBNER has been appointed Professor of Mechanical Engineering in the University of Illinois. He is a graduate of Stevens Institute, and for four years was Professor of Mechanical Engineering in the State Agricultural College at Ames, Iowa.

THE Offices of the MOFFETT, HODGKINS & CLARKE COMPANY, Consulting and Constructing Engineers and Contractors, have been consolidated and established at Nos. 16–22 William Street, New York City. The offices have heretofore been in Syracuse, N. Y., with a branch in New York City.

PROFESSOR J. B. JOHNSON, of Washington University, in St. Louis, has been chosen a Vice-President of the American Association for the Advancement of Science, and Chief of the Section of Mechanical Science and Engineering. PROFESSOR OLIN H. LANDRETH, of Vanderbilt University, Nashville, Tenn., has been chosen Secretary of that section.

R. H. HOOD has been appointed Professor of Civil Engineering in the University of Missouri. He is a graduate of the Rensselaer Polytechnic Institute, and has had much practical experience, having been engaged in railroad, canal and mining surveys in various capacities, and having served for several years as Chief Engineer of the Seaboard Air Line.

JOHN FRITZ, Chief Engineer and Superintendent of the Bethlehem Iron Company, has recently passed his 70th birthday, and to commemorate that date a number of his friends, members of the Engineers' Club, met in Bethlehem, Pa., September 28, and entertained Mr. Fritz at dinner at the Wyandotte House. Many congratulations were extended him on his continued good health and the great success of the works under his charge.

OBITUARIES.

FRANK C. AVERY died suddenly September 10, on board an express train while on his way from New York to Flat Rock, N. C., on a vacation trip. He was Secretary and Manager of the New York Railway Supply Company, and had many friends, who will regret his untimely loss.

JOHN H. HANDREN, who died in Brooklyn, N. Y., September 5, aged 60 years, was for many years engaged in the building of marine engines in New York and Brooklyn, and had made a reputation as a marine engineer and skillful machinist. He was head of the firm of Handren & Robins, and a large number of steamers of various sizes have his engines in them.

JAMES B. FRANCIS, who died at his residence in Lowell, Mass., September 18, aged 77 years, was born in England, but came to this country at an early age. When still a young man he entered the service of the Locks & Canals Company, which controlled the great water-power of the Merrimac at Lowell, and remained with that company for many years, becoming its Chief Engineer. For some time past he has been Consulting Engineer. Mr. Francis had secured a high reputation as a constructing and hydraulic engineer; he served one term as President of the American Society of Civil Engineers, of which he was one of the oldest members.

COLONEL STEPHEN STATES LEE, who died at his residence near Baltimore, August 25, aged 80 years, was born in South Carolina and educated as a civil engineer. In 1835 he was employed in building the old Stonington Railroad, now the New York, Providence & Boston, and served also on other eastern and western lines. In 1843 he became interested in the Cumberland coal fields in Maryland, and for many years was employed there as consulting engineer on mining and railroad work, and later as Manager of the Mt. Savage Coal Company. Nearly 20 years ago he retired from business with a considerable fortune, and since then has spent a large part of his time in France.

GENERAL JOSEPH R. ANDERSON, of Richmond, Va., died September 7, at the Isles of Shoals, where he was spending the summer. He graduated from West Point in 1832, and served for a number of years in the Engineer Corps of the Army, which he left to assist in the establishment of the celebrated Tredegar Works, in Richmond. During the war he was in the Confederate service for a short time, but was for most of the time engaged in the management of his works, which supplied material for the Confederate Army. Since the war he has been President of the Tredegar Company, and until very recently has retained the active management of the works. Although he was 80 years old at the time of his death, his business activity was but little abated. He leaves a large fortune.

COLONEL EBEN C. SMEED, who died in Philadelphia, August 24, aged 61 years, was born in Windsor, Vt., and at an early age began work in an engineer corps in Northern Pennsylvania. He was employed for a long time on the Erie Railroad, and was Assistant Engineer in the building of the old Portage Viaduct. Later he was on the Delaware, Lackawanna & Western, and built the large stone arches near Scranton on that road. In 1861 he entered the Army and served throughout the war, being most of the time Assistant to General Haupt in the Department of Military Transportation. Later he was on

General Thomas's staff, and had charge of the reopening of the railroads when the advance to Chattanooga and later to Altoona was made. At the close of the war he declined a commission in the Engineer Corps, and in 1866 became Resident Engineer of the Kansas Pacific, being shortly afterward appointed Chief Engineer. When that company was consolidated with the Union Pacific, he was made Assistant Chief Engineer, and held that position until he became Chief Engineer on the retirement of Mr. Bogue in 1891. Mr. Smeed was noted among engineers for his readiness in emergencies and his fertility in expedients, and distinguished himself both during the war and while on the Kansas and the Union Pacific.

At a meeting held September 6, 1892, at the office of the Consolidated Car Heating Company, Albany, General Manager Sewall announced the death of Mr. Leighton, and after a few remarks Vice-President Rice offered the following minute, which was seconded by Mr. James F. McElroy and adopted :

"The officers and employés of the Consolidated Car Heating Company learn with sorrow of the death of their associate, Mr. James T. Leighton, of New Haven, and at this their first meeting since that sad event desire to put upon record an expression of appreciation of the admirable qualities which endeared Mr. Leighton to so large a circle of friends. Though in the last few years failing health made him able to take up only part of that full measure of service which formerly brought him in active contact with railroad men throughout the country, yet whatever work fell to him was always done cheerfully, and wherever he came he was always accorded a generous welcome.

"His life was that of a Christian gentleman, continually thoughtful for others. His loss will truly be felt in many places outside his own family. We deeply sympathize with those of his own household, and trust that these few words may in slight degree convey to them the affectionate regard in which James T. Leighton was held by those who knew him best in business life during the few years just past."

PROCEEDINGS OF SOCIETIES.

New England Roadmasters' Association.—The 10th Annual Convention of this Association began in Springfield, Mass., August 25. The usual reports of the officers were presented, and the following officers were chosen for the ensuing year : President, C. B. Lentell, Boston & Albany ; Vice-President, F. H. Holbrook, New York, New Haven & Hartford ; Chaplain, E. W. Horner ; Secretary and Treasurer, G. L. R. French, Boston & Maine ; Executive Committee, W. T. Mosher, F. C. Clarke, T. B. Bodwell and F. E. Sibley.

Reports were then presented by the different Committees on Heavy and Light Rail Sections ; on the Best Material and Form for Small Culverts and Cross Drains ; on Fire Damages, and on the Use of Cheap Material and Tools.

In the evening the Association held its annual dinner, at which about 80 members were present. In the course of this a testimonial was presented to William F. Ellis, who was for seven years Secretary of the Association.

On the second day Mr. W. F. Ellis read an interesting paper on Rail Sections, which was illustrated with drawings, and in the course of which the strong and weak points of different sections were pointed out. The Committee report, which was in favor of the use of heavier rails, was discussed by the members, and was generally approved. The general opinion was also in favor of the use of tie-plates.

The Committee on Small Culverts and Cross Drains reported, recommending several forms of culvert. Their report was also discussed, and several plans for building culverts were suggested. The use of iron pipe was also recommended by a number.

The report on Fire Damage was accepted without discussion. The Committee recommended frequent and careful inspections and the keeping clean of the right of way. The remaining Committee report denounced strongly the practice of purchasing cheap goods of inferior quality.

After passing the usual resolutions of thanks, and deciding to hold the next convention in Boston, the Association adjourned. The meeting closed by an excursion to Greenfield on a special train over the Connecticut River Railroad.

Master Car-Builders' Association.—A circular from Secretary John W. Cloud announces the results of the letter-ballots ordered by the last Convention.

On the first—the change in the Wheel Guarantee—there were 503 votes in favor and 311 against. This change is therefore rejected, having failed to receive the two-thirds vote required.

The second—the standard M. C. B. Coupler Gauges—was adopted, receiving 764 votes, with only 49 in opposition. These are the gauges submitted by the Executive Committee, which were described and illustrated in the JOURNAL for August last, page 386.

A circular from Secretary John W. Cloud gives the subjects and committees for the Convention of June, 1893. There are four committees on the M. C. B. Standards as follows :

1. Drawbars and Brake-beams.—To consider the suggestions of the Committee on Standards, as to standard height of Drawbars, and as to standard form of Brake-beam, and report with recommendations and drawings in detail. Committee : E. D. Nelson, John Bean, J. R. Rankin and C. A. Schroyer.

2. Axles, Journal Boxes, Lids and Wedges.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Committee : R. H. Soule, W. H. Day and W. H. Lewis.

3. Truck Pedestals and Safety Chains.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Committee : T. A. Bissell, William McWood and A. E. Mitchell.

4. Protection of Trainmen and Lettering Fast Freight Line Cars.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Committee : E. P. Lord, Robert Walker and Thomas Sutherland.

The committees other than those on Standards are as follows :

5. Tests of M. C. B. Couplers.—To arrange for and conduct the tests, as proposed by the Committee of 1892 and approved by the Convention, and to consider and report upon all other questions connected with the M. C. B. coupler which they might consider advisable, with the exception of the attachment at the rear end of the coupler and the form of the coupler at that point. To confer with the Committee on Attachment of M. C. B. Couplers to Cars. Committee : J. M. Wallis, J. S. Lentz, R. D. Wade, J. H. McConnell, E. Chamberlain and T. G. Duncan.

6. Attachment of M. C. B. Couplers to Cars.—To recommend a form, in detail, of M. C. B. coupler at rear, and so as to take yoke, tail bolt and continuous draw-bar attachments ; also to consider and report upon the best form of draft attachment to cars. To confer with Committee on Tests of M. C. B. Couplers. Committee : E. D. Bronner, W. H. Harrison, A. M. Waitt, William Garstang, A. Dolbeer and John H. Davis.

7. Metal for Brake Shoes.—To investigate the relative friction and wear of different metals and different shoes in general use on chilled treads and on steel tires. Committee : William Forsyth, Benjamin Welsh and F. D. Adams.

8. Cast-Iron Wheels.—To investigate and report whether there is any substantial difference in wheels made by different methods, such as by solid chills or contracting chills, or by any other difference in process of manufacture. Committee : G. W. West, W. H. Thomas and John Player.

9. Steel-Tired Wheels.—To investigate further and report with all data available as to relative values in service. Committee : R. E. Marshall, J. O. Pattee and C. H. Cory.

10. Air-Brake Tests.—To further investigate and report in detail what tests are desirable to insure best available service. Committee : G. W. Rhodes, E. B. Wall, George Gibbs, A. S. Vogt and E. A. Williams.

11. Freight-Car Truck Frames.—To include in its report the relative advantages of fixed bolsters and swing bolsters. Committee : J. C. Barber, W. S. Morris and S. A. Crone.

12. Steel Center Sills.—To consider and report whether the use of steel for center sills in freight cars would be desirable. Committee : D. L. Barnes, J. N. Barr and J. D. McIlwain.

13. Steam Heating and Ventilation of Passenger Cars.—To review the report of last year's committee on this subject, which was acted on provisionally, and to recommend any changes that may be deemed proper ; also to further pursue the subject of steam heating in general, informing the Association as to what improvements, if any, is being made over the methods now in use. Committee : L. B. Paxson, J. J. Hennessy, Joseph Townsend, John Hodge and David White.

Master Car and Locomotive Painters' Association.—The annual convention began at the Russell House, in Detroit, Mich., September 14. President J. A. Goheen delivered the annual address, and the Secretary presented his report, showing 122 active and 32 honorary members, with a balance of $111 in the treasury.

The election of officers resulted as follows : President, William O. Quest, of Pittsburgh ; Vice-President, William J. Orr,

of Rochester, N. Y.; Second Vice-President, W. T. Leopold, of Savannah, Ga.; Secretary and Treasurer, Robert McKeon, of Kent, O. Mr. McKeon has held this position in the Association for 18 years.

At the evening session and at the two sessions of the following day the committee reports were presented and discussed, according to the programme which was published in the September number of the JOURNAL. A number of questions submitted by members were also discussed.

The attendance at the meeting was very good; some valuable papers were presented, and the discussions called out many notes of practical experience, showing that the Association is actively maintained by the interest of its members.

American Society of Civil Engineers.—The first regular meeting of the season was held on the evening of September 7, President Mendes Cohen in the chair. The Secretary read papers on the Increasing Cost of Railroad Tie Renewals, by Benjamin Reece, and on Thin Floors for Bridges, by Albert F. Robinson. These papers were received early enough for presentation to the annual convention, but were not then read or discussed on account of lack of time. According to the decision of the Board these papers will be immediately published in the *Transactions*, but written discussions will still be received.

Mr. Reece's paper was briefly discussed by Mr. Cohen, and Mr. Robinson's by Messrs. T. C. Clarke and George S. Morison.

It was announced that the Board of Direction by an unanimous vote elected William Hazel Wilson as an honorary member. Ivor Ludwig Sjöstrom, Chehalis, Wash., was elected by the board to Junior membership.

The election by letter-ballot of the following candidates was announced:

Members: Cary Calvert Barr, Jersey City, N. J.; George William Catt, New York; James Edgar Denton, Stevens Institute, Hoboken, N. J.; Theodore Semenovitch Shmeleff, Reval, Russia.

Associate Members: Walter Eugene Angier, Memphis, Tenn.; Austin Lord Bowman, Roanoke, Va.; Loomis Eaton Chapin, Canton, O.; Edward Wilkins Dewey, New York; Frank Lynwood Garrison, Philadelphia, Pa.; Alva Jarvis Grover, Omaha, Neb.; Dunkin Wirgman Hemming, Baltimore, Md.; Peter Elbert Nostrand, New York; Max Ernst Robert Toltz, St. Paul, Minn.; Maurice Augustus Vielé, New York; George Smedley Webster, Philadelphia.

AT the regular meeting on September 21 two papers were presented, one on Strength and Weathering Qualities of Roofing Slates, by Professor Mansfield Merriman. The second was on Tests of Power Required to Drive Electric Street Cars, by Louis B. Bonnett.

New York Railroad Club.—At the first meeting of the season, in New York, September 15, Mr. Hugh Baines read a paper on Rolling Stock in its Relation to Track. This was followed by a paper on Boiler Scale and Purification of Feed Water, by Mr. F. A. Stinard. Both papers were discussed by members present.

Technical Society of the Pacific Coast.—At the regular meeting in San Francisco, September 2, William A. Doble and C. P. Feusier were elected members.

Mr. M. B. Kerr, of the Geological Survey, read a paper on the Geographical Position and Height of Mount St. Elias, Alaska. In this the reader gave an account of his personal experiences while making the ascent, and discussed at length the difficulties standing in the way of an accurate measurement of the height of Mount St. Elias. The lecture was illustrated by stereopticon views.

NOTES AND NEWS.

The Hurontario Ship Railway.—At the last session of the Ontario Legislature an act was passed incorporating the Ontario Ship Railway Company. The project of this company is to build a three-track railroad from Toronto on Lake Ontario, to Collingwood, on Georgian Bay, in Lake Huron, for the purpose of hauling lake vessels between those two points.

Simply stated, the plans provide for basins or docks at the terminals, which can be emptied and filled at will, and where the vessels can be floated on and off the enormous car designed to transport them. On the car the vessels will rest securely on cradles. The car itself will be drawn by six or more powerful locomotives.

The Ontario Ship Railway will be about 66 miles long, and will run from Collingwood, on Georgian Bay, to the mouth of a small river west of Toronto. Georgian Bay is an arm of Lake Huron, and this ship railroad would make a new route between Lake Huron and Lake Ontario, by cutting off the round-about course through Lake Huron, St. Clair River, Lake St. Clair, Detroit River, Lake Erie and the Welland Canal, or any part of the route.

Immense adjustable cradles are fitted, or to be fitted, on three railway tracks of the standard gauge, and by this means vessels of all forms or size may be conveyed from basin to basin.—*Marine Record.*

This is the project advocated by Mr. Corthell, of Chicago. The route is one which must have suggested itself to any one who has studied a map of the lakes; the method of building it was the question to be studied.

The New Cunard Steamer.—The *Campania*, the first of the new Cunard steamers, was launched September 8, from the yard of the Fairfield Company, at Govan, Scotland. She is the largest steamer ever built, except the *Great Eastern*, being 600 ft. long and 75 ft. beam, and will, when fully loaded with cargo, passengers and stores, have a displacement which is estimated at over 19,000 tons. This is a displacement by at least 3,000 tons greater than that of any ship, merchant vessel or man-of-war now in existence. It is anticipated that upon her trials, when loaded to a displacement of something over 14,000 tons, she will attain a speed of 23 knots, or nearly 26½ land miles per hour; and she will, not improbably, exceed even this. Upon her voyage she is to make a continuous speed from port to port of 21 knots, or 24.1 land miles, and this speed is tolerably certain to be improved upon after she has made a few trips. Her engines are ready for her, but no part of them will be put on board until she is in the water. The machinery consists of twin phosphor-bronze screws driven by two triple-expansion engines, each capable of indicating up to 15,000 H.P. Each engine has two cranks and five cylinders. Two high-pressure cylinders will exhaust into an intermediate cylinder, which will exhaust into two low-pressure cylinders; and the pistons of these last are on the same rods as the pistons of the high-pressure cylinders. There will be 12 double-ended boilers, each with eight furnaces, and there will be six stokeholds. The funnels, two in number, will be the largest ever made. The rudder, formed of a single steel plate, is so wide that no British firm possessed the necessary machinery for rolling it, and the work had, in consequence, to be entrusted to Krupp, of Essen.

An American Exhibit in South Africa.—A concern known as the Mercantile Corporation of the United States and South Africa, Limited, has made arrangements to hold a permanent exhibition of American manufactures in Cape Town, the capital of the South African Colonies, with the object of building up and increasing trade between the two countries. All kinds of machinery will be shown, and the purpose is to make the exhibit an interesting and valuable one. The company is organized for the purpose of conducting and developing trade. Mr. R. H. Allen is the Secretary at Cape Town, and the agency in the United States is held by the firm of Haase & Vaughan, of No. 140 Pearl Street, New York City.

Prize for Electrical Investigations.—At the last prize contest instituted by the City of Paris for the best electric meter, the prize of 5,000 francs was awarded to Professor Elihu Thomson. With the desire that this sum should serve for the development of the theoretical knowledge of electricity, Professor Thomson requested Mr. Thurnauer, the European Manager of the Thomson-Houston Company, to offer a prize for the best work on some theoretical question in electricity and to organize a committee to propose the subjects, examine the productions and award the prize. The Committee which has been selected is composed of eminent French electricians, and has decided that the prize should be given for an investigation on one of the following subjects:

1. The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dieletric and quantity of charge.

2. It has been shown theoretically that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents as soon as the resistance of the conducting body decreases below a certain limit. The formula that permits calculating the period of this oscillation has not yet been completely verified. This period of oscillation should be investigated experimentally under conditions such that the exact measure of resistance, capacity and coefficients of self-induction may be possible, in order to arrive at a complete and precise verification of this formula.

3. When a condenser made with an imperfect insulating material has been charged and then left to itself, the charge is gradually dissipated. The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material. It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not present themselves in metallic conductors, and whether these can be shown experimentally.

4. It is proposed to arrange and systematize our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods as in graphical statics.

The theses presented may be written in English, French, German, Italian, Spanish or Latin. They may be in manuscript, or printed.

Each thesis presented must be signed by a pseudonym and accompanied by a sealed envelope bearing the same pseudonym on the outside, and with the name and address of the author inside.

The papers must be sent before September 15, 1893, to B. Abdank-Abakanowicz, Consulting Engineer, the Secretary of the Committee, at 7, Rue du Louvre, Paris, who will furnish any further information required.

A Handy Reading Chair.—The illustration annexed shows the construction of a chair for use in reading, which is said to be very nearly a representation of one preserved at Walmer Castle, which was used by the Duke of Wellington. The

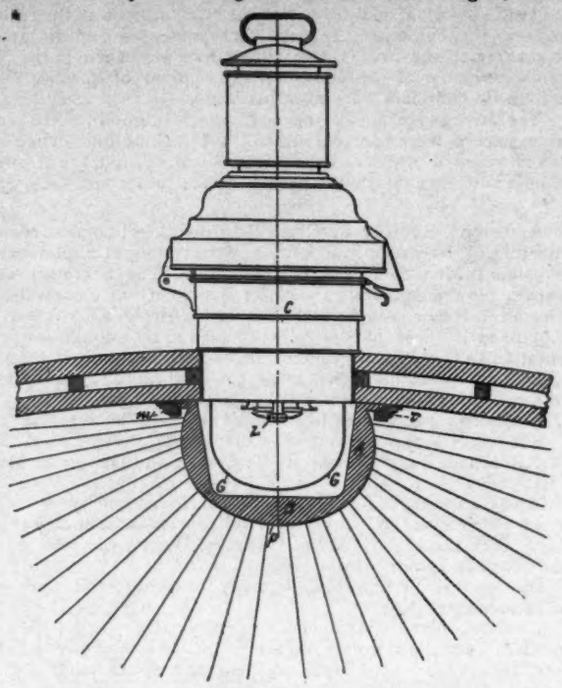
A PECULIAR READING CHAIR.

illustration explains itself. The seat may be stuffed and upholstered to suit, and the desk can be made to rest at any desired inclination.—*English Mechanic.*

A Railroad Car Lamp.—The accompanying drawing shows a form of lamp for cars which has recently been patented by August Nieuwenhuys, of Brussels, Belgium. The object is to increase the brightness and steady the vacillating light generally found in railway carriages or coupés by concentrating the luminous rays emitted by the lighting appliances, of whatever kind they may be, by means of a glass or crystal projector of special lenticular construction, which is applied around the usual glass globe of the lamp. By this means is obtained a much more intense and steady light, less fatiguing to the eye, and enabling one to read easily when at present no reading is possible.

In the drawing the arrangement is shown in section, as applied to the ceiling of a car, with a lamp of any kind. In this drawing *L* is the lamp inserted in the ordinary chimney *C*; *G* is the ordinary glass globe which incloses it, and *P* is the projector or globe of concentration, which is suspended by a flange *r* in a circular groove *m*.

In order to effect concentration of the light, the walls of the projector must be of lenticular form, such that the light is projected and concentrated in all directions. It is therefore necessary to combine several lenticular bodies, the surface of the whole of these being approximately that of a sphere concentric with the flame or illuminant. In the present example the problem is solved by combining a lenticular convex ring *A*, some-



NIEUWENHUYS' CAR LAMP.

what conical in section, with a horizontal convex lens *B*, forming the bottom, the whole being a kind of globe which can easily be made in one piece and the external spherical surface of which accurately reflects all the luminous rays in all directions.

It might be objected that by the use of the projector *P* the ordinary globe becomes superfluous and that the projector alone would suffice; but there would be a serious inconvenience in doing away with the glass globe, because the heat of the lamp *L* would be received directly on the projector *P*, which might cause it to crack, particularly along the line of junction of the lenticular ring *A* with the lens *B*, the thickness of glass along this circle being out of proportion to the rest. This risk is completely avoided by retaining the globe *G*, which prevents the heat from reaching the projector, the temperature of which remains the more uniform as its interior is ventilated by its communication with the chimney *C*. The result is therefore attained simply by applying the globe to a lamp of any nature or construction for perfectly lighting a railroad car.

The Tower Bridge.—The accompanying illustration, from *Industries*, gives an elevation and plan of the Tower Bridge, now in course of erection over the Thames in London. Of this bridge *Industries* says: "Probably the same weight and exceptional workmanship have never been crowded into so small a compass as in the Tower Bridge. The weight of mild steel in the total structure will be 12,000 tons. Some idea of this quantity may be had from the fact that it is equal to a mass of steel 12 in. thick, 60 ft. wide, and a length equal to that of the bridge. Of this quantity 8 000 tons are already on the works. The approach to the bridge is 70 ft. wide, which is reduced to 60 ft., and further reduced to 50 ft. over the center span. The bridge consists mainly of three spans. The center span, of 200 ft., for the passage of ships, is an opening span on the bascule or lifting type, opening in two leaves. These are balanced on the main piers built in the middle of the river. Each pier carries a series of steel octagonal columns forming a tower, which will be cased with masonry. From these towers are carried two independent foot-bridges at a height of 150 ft. above the water level, and one end of each side suspension span.

"Access will be obtained to these foot-bridges by hydraulic lifts worked inside the towers when the central span is opened for the passage of ships. The foot traffic will thus be continuous at all stages of the tide, but vehicular traffic will be stopped during the time the bascule span is open. The foot-bridges are now continuous across the river from tower to tower. These foot-bridges are 12 ft. wide and about 240 ft. long, and

weigh, together, about 500 tons. They are built on the cantilever principle. A cantilever of 60 ft. projects from each tower, and these carry a central girder of 120 ft. span by means of

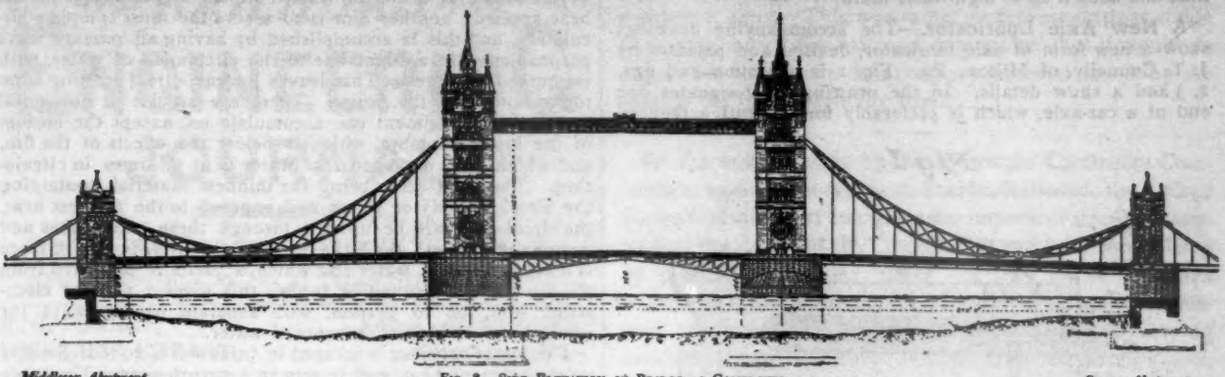


FIG. 3.—SIDE ELEVATION OF BRIDGE AS COMPLETED

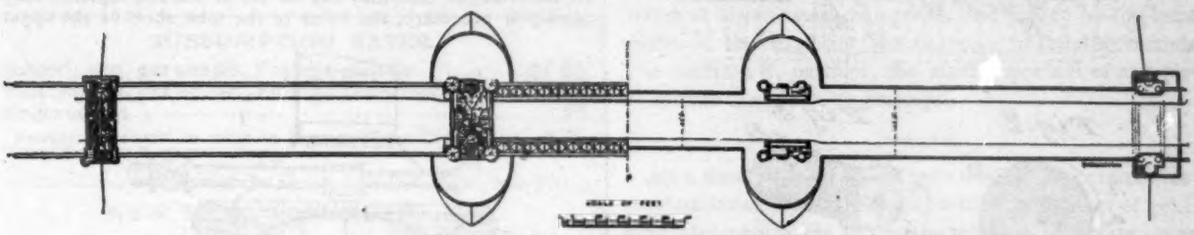


FIG. 4.—SEMI PLANS OF BRIDGE AT TOP AND ROAD LEVEL

THE TOWER BRIDGE OVER THE THAMES, LONDON, ENGLAND.

6-in. flat steel rods suspended from the ends of the true cantilevers.

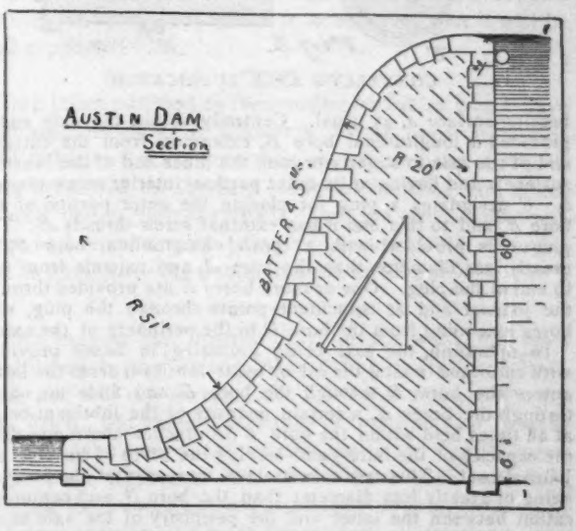
"The center or lifting span is carried by four main ribs from each pivot, meeting at the center of the river. These ribs are 16 ft. 2 in. deep at the haunches, the flanges being 3 ft. wide, and are now being built on their respective piers, end on—that is to say, with the girders pointing up in the air and the span open. Between these main ribs will be fixed cross-girders and buckled plates, on which a wood roadway will be laid. Each leaf of the opening span will weigh 1,000 tons, of which 50 tons was built on a stage rolled forward and turned up vertically. Each leaf measures 113 ft. 3 in. long, and is 50 ft. wide, while it has a counterbalance part weighted with 300 tons of lead. The pivot which carries each leaf is 21 in. diameter, 40 ft. long, and alone weighs 26 tons. The holes in the girders will be bored *in situ*. Each leaf will be raise and lowered by means of a rack having 42 ft. radius worked by means of gearing from hydraulic engines fixed in the body of the pier. The side spans of the bridge are supported by brace girders, each girder being really a huge chain of two links, one end carried on the top of the steel columns on the pier, and the other by similar columns on the abutment. To allow for expansion and contraction of the metal they are carried on roller bearings. The roadway is suspended from these braced girders. From the abutments these braced girders or chains are carried down below the ground and anchored to large foundation girders bedded in a huge mass of concrete. To counteract the pull of the chains on the towers, a horizontal main tie for each chain is carried from tower to tower. Some idea of the magnitude of these ties may be gathered when we state they are 301 ft. long, 2 ft. deep, and 8 in. thick.

"The floor of the side spans is carried by cross-girders pitched 18 ft. apart, suspended by steel rods from the chains. Upon the cross-girders are fixed the bearing or distributing girders, eight in number. Upon these again is fixed a stamped steel corrugated floor, with 7½-in. corrugations and metal ⅜-in. thick.

"The hydraulic power for working the lifts and the two leaves of the center span is generated on the Surrey side of the river. The whole of the machinery for this part of the work is being supplied by Messrs. Sir W. Armstrong, Mitchell & Company, Newcastle-on-Tyne. Mr. J. Wolfe Barry is Chief Engineer.

"The steel octagonal columns forming the towers of the abutments will be cased in with ornamental masonry, and similar masonry will shroud the columns on the piers, a portion of which is completed."

The Austin Dam.—The accompanying sketch shows a cross-section of the dam now in course of erection at Austin, Tex., and is from the report of Mr. J. T. Fanning, Consulting Engineer. This dam will be 1,125 ft. long and 70 ft. high in the center; it is of solid masonry, faced with granite. It is estimated that at high water 250,000 cubic feet of water per second will pass over the crest of the dam, a greater overflow than is known at any dam in the world. The dam will cause a backwater extending some 25 miles up the river, and abundant storage is provided for the dry season. It will furnish a large



amount of power, besides a water supply for the city and for irrigation.

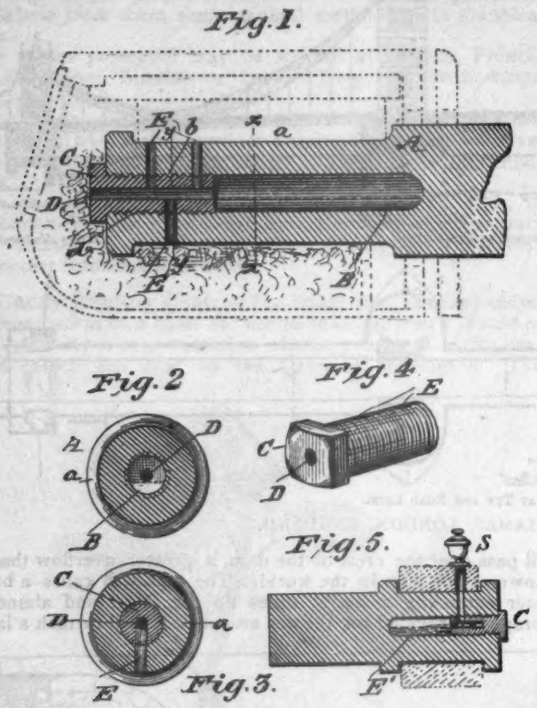
Damming the Rio Grande.—A press dispatch says that a company has been incorporated under the laws of New Mexico for the purpose of putting a big dam across the Rio Grande to store water for irrigating both in Mexico and the United States. William Hamilton, of New York, is at the head of the project, and the company is incorporated for a capital of $10,000,000.

The dam will be built about 5 miles above El Paso in Mountain Gateway. It will be 560 ft. long, of solid masonry from cliff to cliff, resting on a solid limestone foundation, and will be 70 ft. wide.

There will be two double iron gates on the Texas side of the cañon and two of precisely the same size and pattern on the Mexican side. From these gates two canals will be cut through the rock, following the bluff on the Mexican side, capable of carrying a volume of water 20 ft. wide and 10 ft. deep. The cost of the dam and canals is estimated at $2,500,000. The construction of this dam will create an inland lake 15 miles long and about 5 miles wide, with an average depth of about

25 ft. Storage reservoirs will be constructed on both sides of the cañon above, also, so as to replenish the lake from time to time and keep it up to high-water mark.

A New Axle Lubricator.—The accompanying drawings show a new form of axle lubricator, devised and patented by J. T. Connelly, of Milton, Pa. Fig. 1 is a section and figs. 2, 3 and 4 show details. In the drawings *A* designates one end of a car-axle, which is preferably formed with a reduced



CONNELLY'S AXLE LUBRICATOR.

bearing-surface *a*, as usual. Centrally within the axle end is provided a longitudinal bore *B*, extending from the extreme end of the axle to slightly beyond the inner end of the bearing-surface *a* and having at its outer portion interior screw-threads *b*. *C* designates a plug for closing the outer portion of the bore *B*, and to this end it has external screw-threads *d*. The plug *C* is provided with a central longitudinal bore *D*, of greatly less diameter than the bore *B*, and extends from end to end of the plug. One or more bores *E* are provided through the journal and at coincident points through the plug, said bores extending from the bore *D* to the periphery of the axle.

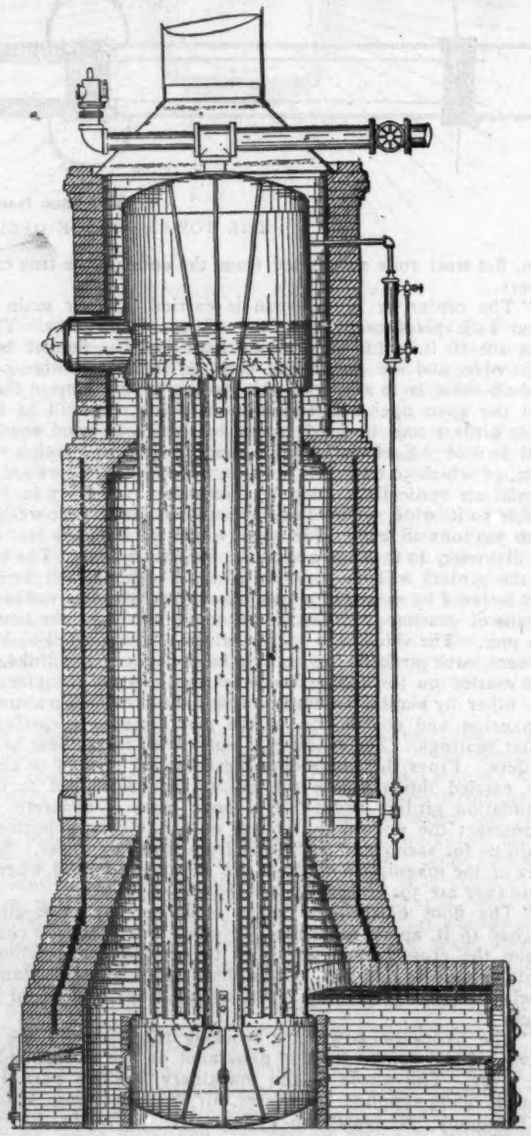
In operation, the axle being journaled in boxes provided with saturated waste, the oil or other lubricant from the latter enters the bore *B* through the bore *D* and finds an outlet through the bores *E*, a certain quantity of the lubricant being at all times held within the bore *B* (in practice about one-third the capacity of the latter) and serving the office of keeping the journal cool. This result is attained by reason of the bore *D*, being of greatly less diameter than the bore *B*, and communication between the latter and the periphery of the axle being had only through the bore *D*, the lubricant when it reaches the level indicated in dotted lines, fig. 1, finds no outlet, the remaining quantity being thus permanently retained within the bore *B*, for the purpose mentioned.

This device can be applied also to crank-pins and similar journals. For such bearings the arrangement is shown in fig. 5; here the outer end of the plug is closed and an oil-cup, *S*, is carried by the bearing for the journal and has its outlet in a direct transverse plane with a bore, *E'*. Thus as the journal revolves the latter bore coincides with the outlet of the oil-cup, and the lubricant passes therefrom to the interior of the journal; but when the bore is removed from the outlet the lubricant is deposited upon the periphery of the journal to lubricate the same.

A New Boiler.—The accompanying drawing, from the *Iron Trade Review*, shows a boiler devised by Herbert F. Cook, of Cleveland, O., for which the advantages of quick steaming, free circulation and freedom from deposit of scale are claimed. A boiler of this class has been in use at the Cherry Valley Iron Works in Leetonia, O., for some time, with excellent results, and others are now under construction.

This boiler is of the vertical water-tube type and is set in brick-work, as shown in the accompanying illustration. One object aimed at is the utilization to the largest degree of the heat applied; another aim is to secure the most complete circulation, and this is accomplished by having all passage ways perpendicular to a direct line to the circulation of water, with no curved passages. This leaves a clear, direct opening from top to bottom of the boiler. There are no flat or horizontal surfaces that sediment can accumulate on, except the bottom of the lower chamber, which is below the effects of the fire, and which is so arranged that water is at all times in circulation. The outer tubes being the thinnest material, containing the smallest body of water and exposed to the greatest heat, the circulation will be upward through these outer tubes and downward through the large flue in the center, in which there is a larger body of water and which is partially protected from the fire by the surrounding tubes; this gives a positive circulation from top to bottom, with separate passage-ways for upward and downward currents of water.

The upper chamber is incased in brick-work, so that there is no radiation of heat, and it acts as a superheater. The tubes are so arranged that they can be taken out and replaced very quickly if necessary, the holes in the tube sheet of the upper



COOK'S TUBULAR BOILER.

chamber being made ¼ in. larger than the tube, with copper ferrules on so that when the tubes are loosened for the purpose of taking them out, the lower end will cant over far enough to allow them to be slipped down the side of the boiler and passed up between the brick-work and the outer side of the upper chamber.